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                         Vocational Education  
 IDENTIFIERS           \*Ohio

## ABSTRACT

This document contains 397 competencies, grouped into 58 units, for tech prep programs in the engineering technologies cluster. The competencies were developed through collaboration of Ohio business, industry, and labor representatives and secondary and associate degree educators. The competencies are rated either "essential" (necessary to ensure minimal levels of employability by entry employees; must be included in all new tech prep programs) or "recommended." Competency builders are included for each competency. A matrix relates the units to five occupations within the engineering technologies occupational cluster. Some of the groups of competencies covered in the units include the following: employability skills; professionalism; teamwork; professional practices; workplace safety; project management; problem analysis; general administrative functions; economic and business principles; basic computer concepts and applications; quality assurance; technical recording and reporting; supervision; drafting technology; visualization and design for function; computer-assisted design/drafting technology; electricity; fundamentals of electronics technology; analog circuits; digital logic circuits; microcomputer electronics technology; instrumentation control technology; electro-optic technology; electronics troubleshooting and repair; electronic product servicing technology; industrial electricity; wiring methods; electronic assembly and repair; equipment maintenance; industrial manufacturing; electromechanical technology; hydraulics and pneumatics; computerized numerical control; precision machining; metal stamping dies; press technology; sheet metal fabrication; material joining technology; and welding basics. (KC)

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## Engineering Technologies

## State Competency Profile

May 7, 1998  
Columbus, Ohio

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## Engineering Technologies State Competency Profile

This document is the result of collaboration between a number of individuals and organizations. The Ohio Department of Education and the Ohio Board of Regents provided financial and staff support for the development of the document. Dr. Richard Bailey, Tech Prep Consultant, drafted key units and edited the initial document upon which the current document is based. Guidance in document development was provided by a futuring panel composed of Ohio Business, Industry and Labor Representatives. (See attached list of Futuring Panel Members.)

The current document is a result of a review by a state-wide panel of business/industry/labor representatives and secondary/associate degree educators on May 7, 1998. (The name and institutional affiliation of each panel member is provided on the following pages.) Jan Eley, Akron Area Tech Prep Consortium, Linda Fauber, Lakeland Tech Prep Consortium, Jennie Royer, Stark Tech Prep Consortium, and Julie Daugherty, Eastern Ohio Valley Tech Prep Consortium served as meeting facilitators.

As you review the document, keep in mind the following:

### *Essential Competencies*

Those competencies marked *Essential* in the State Competency Profile were determined by the statewide business/industry/labor panel to be necessary to ensure minimal levels of employability. Entry level employees should be able to perform this competency without supervision; therefore, students must be proficient in these competencies at least by the end of the Associate Degree.

*Essential* competencies must be included in all new Tech Prep programs. Tech Prep consortia with current programs in this area will be expected to phase-in essential competencies into their programs as well.

Wording of essential competencies may not be altered. The leveling may only be changed to deliver the competency earlier during the educational process. For example, the leveling of an essential competency in the State Competency Profile may be altered locally from a P or

Proficiency leveling at the end of the Associate Degree to a P or Proficiency by the end of the 12th grade. The reverse is not permissible. For example, a competency leveled P or Proficient by the end of the 12th grade in the State Competency Profile cannot be changed locally to a P or Proficiency by the end of the Associate Degree. For additional information on leveling of competencies, refer to the Leveling Code Sheet.

Competency builders are intended to help define each competency; therefore, the builders may be modified as long as that modification does not change or dilute the intent of the State Panel.

Issues which arise regarding delivery of the *essential* competencies once the program is implemented will be addressed by a State review panel of business/industry/labor and education representatives with possible revisions to the State Competency Profile at a later date. Any issues identified during the local verification meeting should be conveyed to Tech Prep Curriculum Services by the meeting facilitator.

#### ***Recommended Competencies***

The competencies marked *Recommended* are suggested additions to the State Competency Profile. Each of these competencies should be reviewed during a local competency profile meeting; with a joint panel of business/industry/labor and education representatives deciding whether to include each competency in the local curriculum. The decision should be based upon a consideration of local business needs, as well as priorities and time constraints of the educational process. Wording and leveling of all recommended competencies and builders may be modified.

#### ***Additional Units/Competencies/Builders***

Competencies and/or builders may be added to any unit in the State Competency Profile. Additional units may also be added.

#### ***Occupation Definitions***

Skills may be added to the occupational definitions based on the modifications made during the competency review. Because the definition is based on the skills detailed in the competency profile, only minor modifications should be necessary.

For additional information about this State Tech Prep Competency Profile contact:

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**Engineering Technologies Future Panel  
April 14, 1998  
Columbus, Ohio**

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Panel Facilitator

**Blaine Lilly**, Assistant Professor  
Department of Mechanical Engineering  
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**Keith Rosnell**, President  
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## **Engineering Technologies State Competency Profile Meeting**

### **Business, Industry, Labor Panel**

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**Perry Ballinger**, Telecommunications Engineer, Electronics  
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**Michael Bentley**, Maintenance Supervisor  
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**Steve Combs**, Training Coordinator, Electrical Department  
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Weirton Steel Corp., Weirton, West Virginia

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Sprint, Mansfield, Ohio

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MBS Engineering Solutions, Cincinnati, Ohio

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**Jeff R. VanZant**, QC, CNC Program Purchasing Supervisor, Industrial Manufacturing Tech.  
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**Mark Winnett**, Director, Order Fulfillment, Plant Operations  
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## **Engineering Technologies State Competency Profile Meeting**

### **Educator Panel**

**David Ackerman**, Electronics Instructor  
Belmont Harrison JVS, St. Clairsville, Ohio

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**David Andrews**, Vocational Education Teacher  
Patterson Career Centers, Dayton Public Schools, Dayton, Ohio

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Perry High School, Massillon, Ohio

**Patrick Beech**, CADD Drafting Instructor, T&I  
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**Dave Bittner**, Engineering Technology Educator  
Lakeland Community College, Kirtland, Ohio

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Clay High School, Oregon, Ohio

**Tom Currie**, Chair, Electronic Engineering Technology  
Columbus State Community College, Columbus, Ohio

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**Ky Davis**, Mathematics Instructor  
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**Daniel Durfee**, Professor, Engineering & Science, Environmental Department  
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Buckeye Local High School, Rayland, Ohio

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**Michael Kouse**, Electronics Instructor  
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**Brian Kelly Kurth**, Engineering/Mathematics Instructor  
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**James Laremore**, Curriculum Chair, Engineering Technology, Science & Communications  
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North Central Technical College, Mansfield, Ohio

**Don Yetzer**, Tech Prep Instructor, Engineering Design, T&I  
Colerain Career Center, Cincinnati, Ohio

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## **LEVELING CODES**

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### **GRADE LEVEL**

12 = by the end of grade 12

AD = by the end of the Associate Degree

### **DEPTH**

I = Introduce (applies to at least three or 25% of the competency builders)

R = Reinforce or add depth (after introducing or proficiency)

P = Proficient (achievement of the competency **without** supervision)

### **ACADEMIC CODES**

C = Communications related

M = Mathematics related

S = Science related

### **OTHER (Determined by Business, Industry and Labor Panel)**

**Essential Competency:** Competency is needed to ensure **minimal** level of employability. Entry level employees should be able to perform this competency without supervision. Competencies required for certification, licensure, and/or national skills standards should be tagged as essential.

**Recommended Competency:** Competency should be included but is not essential for minimal level of employability.

**Delete:** Competency should not be included.

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### **Example:**

BIL: Essential Recommended Delete

EDU	12	AD	AC
	P	R	C

Competency: XXXXXXXX

### **Example:**

BIL: Essential Recommended Delete

EDU	12	AD	AC
	P	R	C

Competency: YYYYYYYY

Competency Builders:

SSS

XXX M

## **Occupational Definitions Engineering Technologies**

**Electronics Technician**—An individual who combines electrical, electronic, and mechanical functions and their interactions. Technical skills should include, but not be limited to:

- quality control and safety devices
- microcomputer applications in industry
- electronic applications of communication equipment
- teamwork skills
- report preparation

**Electrical Maintenance Technician**—An individual who applies basic engineering principles and technical skills supporting electrical, electronics, and communication engineers. Technical skills should include, but not be limited to:

- electrical circuitry
- prototype development and testing
- systems analysis and testing
- systems maintenance and repair
- instrument calibration
- teamwork skills
- report preparation

**Electromechanical Systems/Electrical Maintenance Technician**—An individual who applies electrical theory and related knowledge to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial settings. Technical skills should include, but not be limited to:

- causes of electrical or mechanical malfunction or failure of equipment
- preventative and corrective maintenance
- equipment modification and/or replacement
- mechanical and electrical equipment and systems testing, troubleshooting, repair, and modification
- test data analysis and interpretation
- adjustment, calibration, alignment, and modification of circuitry and components
- teamwork skills
- report preparation

**Industrial Manufacturing Technician**—An individual who applies basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and/or using manufacturing systems and processes. Technical skills should include, but not be limited to:

- machining skills
- print and schematic interpretation
- geometric dimensioning and tolerancing
- basic CADD skills
- basic electrical skills
- computerized numerical control
- programmable logic controllers
- operational diagnosis, repair, and maintenance procedures
- manufacturing methods specification and implementation
- statistical process control
- teamwork skills
- report preparation

**CADD Technician**—An individual who applies technical knowledge and skills to plan and prepare computerized pictorial interpretations of plans and design concepts for mechanical devices and machinery. Technical skills should include, but not be limited to:

- print and schematic interpretation
- proficient drafting and CADD/CAM skills
- drawing designs from approved sketches
- drawing designs from blueprints, designs, mockups, and photoprints
- layouts, drawings, and schematics depicting function, relationship, and assembly sequence of parts and assemblies
- teamwork skills
- report preparation

## Engineering Technologies Cluster

**ET =** Electronics Technician  
**EM =** Electromechanical Systems/Electrical Maintenance  
**Technician**

**IM =** Industrial Manufacturing Technician  
**CT =** CADD Technician

Small Type	Large Type	UNIT	ET	EM	IM	CT
1	1	Employability Skills	X	X	X	X
11	16	Professionalism	X	X	X	X
21	27	Teamwork	X	X	X	X
25	36	Professional Practices	X	X	X	X
29	41	Workplace Safety	X	X	X	X
31	45	Project Management	X	X	X	R
36	50	Problem Analysis	X	X	X	X
39	53	General Administrative Functions	X	X	X	X
43	57	Economic and Business Principles	X	X	X	R
53	69	Basic Computer Concepts and Applications	X	X	X	X
74	97	Quality Assurance	X	X	X	X
94	126	Quality Assurance for IM	X	X	X	X
109	148	Technical Recording and Reporting	X	R	R	R
111	152	Supervision			X	X
113	155	Drafting Technology for IM and CT			X	X
126	173	Drafting Technology for ET and EM			X	X
132	181	Visualization and Design for Function			X	X
134	183	CADD Fundamentals			X	R
142	193	Intermediate CADD			X	X
145	196	Advanced CADD				X
154	209	Basic Electricity			X	X
158	217	Fundamentals of Electronics Technology			X	X

R = Recommended

**ET =** Electronics Technician  
**EM =** Electromechanical Systems/Electrical Maintenance

**IM =** Industrial Manufacturing Technician  
**CT =** CADD Technician

		UNIT					
Small Type	Large Type					ET	EM
161	223	Electronic Noise				X	X
164	226	Analog Circuits				X	X
169	232	Digital Logic Circuits				X	X
173	236	Microcomputer Electronics Technology				R	X
178	244	Instrumentation Control Technology				X	X
185	252	Electro-optic Technology				X	X
190	259	Electronics Troubleshooting and Repair				X	X
198	268	Electronics Troubleshooting and Repair for IM				X	X
200	271	Electronic Product Servicing Technology				R	
207	281	Programmable Logic Controllers (PLCs)				R	X
211	287	Communications Electronics Technology for ET				R	
220	298	Communications Electronics Technology for EM				X	
227	308	Industrial Electricity				X	X
235	322	Wiring Methods				X	
246	334	Electrical Test and Measurement Equipment				X	X
248	338	Electronic Assembly and Repair				X	X
251	342	Equipment Installation				R	X
256	348	Equipment Maintenance				X	X
263	360	Industrial Engineering Basics				X	
267	367	Industrial Manufacturing Technology				X	R
273	375	Basic Materials Science				X	X
285	394	Mechanical Power Transmission				X	X
299	413	Fundamentals of Machine Anatomy				X	X
301	416	Electromechanical Technology				R	X

R = Recommended

ET = Electronics Technician  
EM = Electromechanical Systems/Electrical Maintenance

IM = Industrial Manufacturing Technician  
CT = CADD Technician

Small Type	Large Type	UNIT			ET	EM	IM	CT
		ET	EM	IM				
310	430	Electromechanical Technology for IM				X	X	
319	444	Hydraulics and Pneumatics				X	X	
336	464	Hydraulics and Pneumatics for ET				X		
340	469	Computerized Numerical Control (CNC) for EM				X		
343	473	Computerized Numerical Control (CNC) for IM				X		
350	481	Precision Machining				R		
366	504	Metal Stamping Dies				R		
376	514	Press Technology				R	R	
378	516	Sheet Metal Fabrication				R		
383	522	Basic Moldmaking				R		
393	532	Material Joining Technology				X		
397	536	Welding Basics				X		

R = Recommended

# **Unit: Employability Skills**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:** Develop a career plan # \*

## **Competency Builders:**

Identify current interests and aptitudes

Identify common barriers to employment

Describe strategies to overcome employment barriers

Locate resources for finding employment

Research job trends

Identify career options

Identify advantages and disadvantages of career options (in addition to monetary)

Identify job requirements

Investigate education/training opportunities (including speaking with someone in the trade)

Identify and evaluate personal strengths and weaknesses

Refine a written educational plan which leads to a specific career field

Create career passport

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:**      **Prepare for employment # \***

**Competency Builders:**

- Identify employment sources
- Identify present and future employment opportunities (by geographic location)
- Research job opportunities
- Compare salary ranges and benefit packages
- Compile occupational profile
- Demonstrate ability to accurately complete a job application
- Demonstrate verbal interpersonal communication
- Design resume and cover letter
- Target resume
- Secure references
- Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
- Use follow-up techniques to enhance employment potential
- Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
- Use proper diction in interviews
- Describe methods for handling illegal questions on job application forms and during interviews
- Write letter of application
- Research prospective employer and services performed
- Explain critical importance of personal appearance, hygiene, and demeanor
- Interpret job description
- Demonstrate appropriate interview question and answer techniques
- Demonstrate methods for handling difficult interview questions using simulated role playing exercises
- Evaluate job offers
- Give appropriate notice to employer of job change

Write letter of acceptance  
Write letter of declination  
Demonstrate good listening skills  
Ask for the job tactfully  
Identify the importance of participating in extracurricular activities (e.g., student government, community projects)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Evaluate the importance of self-esteem as an employability skill # \***

**Competency Builders:**

- Identify factors that affect self-esteem
- Compare effects of low self-esteem and high self-esteem
- Identify strategies to promote positive self-esteem

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Demonstrate job retention skills # \***

**Competency Builders:**

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene

Exhibit appropriate work habits and attitude

Demonstrate ability to set priorities

Identify behaviors to establish successful working relationships

Identify appropriate methods for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age

Identify opportunities for advancement

List reasons for termination

List consequences of being absent frequently from job

List consequences of frequently arriving late for work

Demonstrate interpersonal relations skills (e.g., verbal and written)

Demonstrate negotiation skills

Demonstrate teamwork

Follow chain-of-command

Exhibit appropriate job dedication

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Demonstrate knowledge of work ethic # \***

**Competency Builders:**

Define work ethic

Identify factors that influence work ethic

Differentiate law and ethics

Describe how personal values are reflected in work ethic

Describe how interactions in the workplace affect personal work ethic

Describe how life changes affect personal work ethic

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Exhibit appropriate work ethic # \***

**Competency Builders:**

Use time-management techniques

Avoid personal activity during work hours

Attend work as scheduled

Adhere to company and/or governmental policies, procedures, rules, and regulations

Exercise confidentiality

Demonstrate appropriate human relations skills

Adhere to rules of conduct

Accept constructive criticism

Offer constructive criticism

Take pride in work

Resolve conflict

Manage stress

Avoid sexual connotations and harassment

Adjust to changes in the workplace

Demonstrate punctuality

Assume responsibility for personal decisions and actions

Take responsibility for assignments

Follow chain-of-command

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:**      **Apply decision-making techniques # \***

**Competency Builders:**

Identify decision to be made

Identify possible alternatives and their consequences

Make decisions based on facts, legality, ethics, goals, and culture

Apply time factor(s)

Present decision to be implemented

Evaluate decision made

Take responsibility for decision

Identify ownership of decision to be made

Identify risks

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:**      **Apply problem-solving techniques #**

**Competency Builders:**

Identify problem

Select appropriate problem solving tools/techniques

Identify root problem cause(s)

Track root problem cause(s)

Identify possible solutions and their consequences (e.g., long term, short term, crisis)

Use resources to explore possible solutions to problem

Contrast advantages and disadvantages of each solution

Identify appropriate action

Evaluate results

Identify post-preventive action

Document results

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Exhibit characteristics for job advancement # \***

**Competency Builders:**

Display positive attitude

Demonstrate knowledge of position

Perform quality work

Adapt to changing situations and technology

Demonstrate capability/responsibility for different positions

Identify characteristics of effective leaders

Identify opportunities for leadership in work place/community

Demonstrate initiative to affect change in workplace

Participate in continuing education/training program

Respond appropriately to criticism from employer, supervisor, or other employees

Exhibit awareness of corporate culture

Prepare for job setbacks

Exhibit continual growth based on performance evaluation

Set realistic goals

## **Unit: Professionalism**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:**      Project professional image # \*

### **Competency Builders:**

- Define professionalism
- Exhibit professional appearance
- Exhibit professional manners
- Project professional attitude
- Identify individual's vital role in organization
- Exhibit proper etiquette in professionally-related situations

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:**      **Formulate individual and professional goals # A \***

**Competency Builders:**

- Set flexible, realistic, and measurable goals
- Identify potential barriers to achieving goals
- Identify strategies for addressing barriers to goal achievement
- Breakdown long-term goals into short-term goals
- Prioritize goals
- Commit to goals
- Adjust goals
- Obtain support for goals
- Reward goal achievement

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:** **Organize personal finances # \***

**Competency Builders:**

Explain need for personal management records

Balance checkbook

Identify tax obligations

Analyze how credit affects financial security

Compare types and methods of investments

Compare types and methods of borrowing

Compare types and methods of insurance

Compare types of retirement options/plans

Identify discretionary vs. non-discretionary expenditures

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	R	S,C,M

**Competency:**      **Support community well-being \***

**Competency Builders:**

Identify environmental, educational, and social issues

Participate in social and/or community/industry activities

Participate in industry activities and organization

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Contribute to organizational goals \***

**Competency Builders:**

Evaluate personal goals in relation to organizational goals

Monitor progress by evaluating feedback

List responsibilities in relation to organizational goals

Accomplish assigned tasks

Exercise responsibility in relation to organizational goals

Set appropriate personal performance standards

Communicate goals with supervisor and peers

Demonstrate knowledge of products and services

Promote organizational image and mission

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Demonstrate positive relations in the workplace # \***

**Competency Builders:**

Identify personality types

Identify methods of working with various personalities

Identify various management styles

Support organization expectations

Support organization decisions

Accept constructive criticism

Give constructive feedback

Adapt to changes in workplace

List factors to consider before resigning

Write letter of resignation

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:** Manage stressful situations

**Competency Builders:**

- Accept stress as part of daily life
- Identify personal and professional factors contributing to stress
- Describe physical and emotional responses to stress
- Evaluate positive and negative effects of stress on productivity
- Identify strategies for reducing stress
- Identify positive methods to channel stress
- Implement strategies to manage stress
- Create strategies for developing and maintaining support systems

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	R	C,S,M

**Competency:**      **Analyze effects of family on work and work on family**  
#

**Competency Builders:**

- Identify how family values, goals, and priorities are reflected in work place
- Identify responsibilities and rewards associated with paid and non-paid work
- Identify responsibilities and rewards associated with families
- Explain how family responsibilities can conflict with work
- Explain how work can conflict with family responsibilities
- Explain how work-related stress can affect families
- Explain how family-related stress can affect work
- Identify family support systems and resources
- Identify work-related support systems and resources
- Communicate with family regarding work

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**            **Apply lifelong learning skills # \***

**Competency Builders:**

Define lifelong learning

Identify factors that cause need for lifelong learning

Analyze effects of change

Identify reasons why goals change

Describe importance of flexibility and adaptability

Evaluate need for continuing education/training

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Manage professional development \***

**Competency Builders:**

Identify career opportunities

Modify career plan

Participate in continuing education/training opportunities

Document continuing education/training

Read profession-related manuals, technical journals, and periodicals

Attend meetings, workshops, seminars, conferences, and demonstrations

Participate in professional organizations

Build personal/professional mentor relationship

Build personal/professional support system

Build professional network

Strengthen communication skills

Strengthen leadership skills

Strengthen management skills

# **Unit: Teamwork**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:** Demonstrate knowledge of teamwork # \*

## **Competency Builders:**

- Define self-direction
- Define responsibility
- Define accountability
- Differentiate work groups and teams (e.g., internal, external)
- Identify conditions essential to teamwork (e.g., problem solving)
- Explain influence of culture (e.g., corporate, community) on teamwork
- Identify appropriate situations for using teams
- Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
- Identify team building concepts
- Describe characteristics and dynamics of teams
- Identify characteristics of effective team leaders and members
- Identify responsibilities of team members
- Identify methods of involving each member of a team
- Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
- Explain the purpose of facilitators
- Define consensus
- Define reward/recognition system
- Define mutual respect
- Define equality
- Define group dynamics (group think)
- Provide feedback
- Receive feedback
- Define communication styles
- Define management styles
- Define social style
- Define continuous improvement

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Demonstrate teamwork # \***

**Competency Builders:**

Identify purpose of team and intended goal (include time frames)

Structure team around purpose

Define responsibilities of team members (e.g., talents, skills, abilities)

Contribute to efficiency and success of team

Work toward individual and team milestones

Analyze results of team project

Facilitate a team meeting

Assist team member(s) with problem

Monitor time frame

Exhibit continuous improvement

Recognize failure as part of learning

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Use teamwork to solve problems # \***

**Competency Builders:**

Identify appropriate situations for using teams

Identify quality management processes/techniques

Identify quality assurance processes/techniques

Prepare presentation (e.g., business plan & procedure)

Identify problem

Use problem-solving process in a team setting (e.g., Brainstorm, Pareto, Fishbone)

Identify resources

Gather data

Analyze data

Describe solution options

Implement solution options

Review solution

Review case studies

Document results

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Conduct team meetings \***

**Competency Builders:**

- Plan agenda
- Set ground rules (Roberts Rules of Order)
- Schedule meeting and location
- Set time limitations
- Invite appropriate personnel
- Set next team meeting
- Solicit outside speakers as needed
- Select scribe
- Select meeting leader
- Facilitate ground rules
- Select facilitator
- Invite questions and comments and group participation
- Focus team on agenda items
- Assign appropriate action, budget, time frame and accountability to tasks
- Monitor time
- Overcome team impasse
- Close meeting on time
- Publish minutes in timely manner
- Avoid placing individual agendas above the group's agenda

## **Unit: Professional Practices**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:** Explain professional responsibilities \*

### **Competency Builders:**

- Explain the need for professional and ethical standards
- Explain responsibility of the individual to apply ethical standards
- Identify responsibility to client(s) and employer(s)
- Explain consequences of unprofessional and/or unethical behavior
- Explain importance of conflict resolution in the workplace

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      Identify legal and ethical behavior

**Competency Builders:**

Differentiate between legal and ethical behavior

Explain terms, principles, and characteristics of legal and ethical behavior (e.g., loyalty, discretion, solicitation, competitor, supplier)

Explain legal ramifications of breaching rules and regulations

Explain effects of unethical and/or unlawful behavior

Practice within scope of the profession

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Function as a self-managed employee**

**Competency Builders:**

- Propose project (C)
- Organize tasks
- Manage time
- Meet deadlines
- Maintain business records (C)
- Make long-term and short-term plans
- Evaluate progress
- Report progress (C)
- Delegate project
- Acquire appropriate licenses/registrations
- Obtain permits and releases

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:**      **Follow intellectual property rights and copyright laws**

**Competency Builders:**

- Explain purpose of patent
- Explain purpose of copyright
- Explain purpose of licenses
- Explain purpose of trademarks
- Explain rights of the originator
- Explain rights of the public
- Define confidentiality
- Define proprietary
- Explain legal ownership of proprietary material
- Describe stock image/text usage rights
- Explain negotiation of contracts
- Explain reproduction licensing and residual usage

# **Unit: Workplace Safety**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:** **Maintain safe working environment**

**Competency Builders:**

Describe what an MSDS sheet is

Comply with HMIS material safety data sheets (MSDS) and OSHA regulations

Comply with all MSDS regulations regarding hazardous materials

Maintain clean work area by removing waste, keeping alleyways clear, cleaning tools, and preventing spills

Minimize workplace causes of environmental burdening, pollutants, and poisoning

Describe pollution solution limits imposed by permits and regulations

Comply with regulatory guidelines in handling, labeling, and disposal of solutions (e.g., fountain chemicals, inks, wash-up solutions, drum grounding)

Identify visual equipment controls (e.g., monitors, read outs)

Identify auditory equipment controls

Comply with workplace safety rules and procedures

Comply with personal safety rules and procedures

Comply with applicable electrical, mechanical, hydraulic and pneumatic safety rules and procedures

Recycle appropriate materials

Use preventive maintenance checklists

Identify location of control panels, shut-off valves, and fire extinguishers

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S

**Competency:** Demonstrate knowledge of ergonomics

**Competency Builders:**

Define ergonomics

Define risk factor

Define maximum permissible limit (MPL) and action limit (AL) for lifting

Define cumulative trauma disorder (CTD)

Identify susceptibility factors for CTD

Minimize extreme joint movement

Minimize use of excessive muscle/physical force

Minimize repetitive tasks

Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)

Minimize awkward body positions

Explain use of rest pauses

Explain need for mats and footrest for standing jobs

Explain need for appropriate working heights of chairs, stools, workbenches, equipment

Explain need for adequate lighting

Explain use of anthropometric (e.g., centering one's view of everything around man) design

# **Unit: Project Management**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:** Explain project management \*

## **Competency Builders:**

- Identify project purpose/goal
- Identify project objectives
- Identify work breakdown structure (WBS)
- Identify resource requirements
- Identify project economics/funding
- Identify risks

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Plan projects \*

**Competency Builders:**

- Apply responsibility assignment matrix (RAM)
- Apply Gantt or bar charts
- Apply network diagrams
- Apply critical path method (CPM)
- Apply project education and review techniques (PERT)
- Apply software programs

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**      **Implement projects \***

**Competency Builders:**

Monitor project

Control project

Modify project

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**            **Evaluate projects \***

**Competency Builders:**

Analyze performance

Perform critical review of project

Draw project management conclusions

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:** Write project summary \*

**Competency Builders:**

List project goals

Document project's key successes

Document project's key failures

Analyze costs vs accomplishments

## **Unit: Problem Analysis**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C,S

**Competency:** Appraise situations #

### **Competency Builders:**

- Identify concerns
- Set priorities
- Identify resolution process
- Plan resolution

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:** Analyze problems #

**Competency Builders:**

- Identify potential problems
- Identify likely causes
- Test for probable causes
- Verify cause
- Identify preventive actions
- Identify contingent actions

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:** Analyze decisions #

**Competency Builders:**

- Identify objective(s)
- Identify alternatives
- Evaluate alternatives
- Assess risks
- Make final choice
- Determine effectiveness of decision
- Document results

## **Unit: General Administrative Functions**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C,S

**Competency:** **Maintain work flow #**

**Competency Builders:**

Organize work

Prioritize work

Apply time-management techniques

Complete assigned tasks in a timely manner

Coordinate with team members

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:** **Perform telecommunications operations #**

**Competency Builders:**

- Display telephone etiquette
- Operate equipment
- Listen assertively
- Verify information
- Record messages
- Place calls
- Organize teleconferences
- Use voice mail/messaging systems
- Operate fax/modem machine
- Use e-mail systems
- Use Internet communications services
- Use videoconference facilities

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	P	R	C,M

**Competency:** Perform scheduling functions #

**Competency Builders:**

Create calendar/schedule

Maintain and use appointment calendars with accurate addresses and phone numbers

Process requests for appointments

Verify appointments

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Manage records #**

**Competency Builders:**

- Implement filing system
- Implement retention system
- Perform electronic filing operations
- Maintain inventory records
- Retrieve files

# **Unit: Economic and Business Principles**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**      **Describe basic economic concepts # \***

## **Competency Builders:**

- Identify importance of economic resources
- Explain concept of economic resources
- Explain importance of economic resources
- Explain concept of economic goods and services
- Differentiate between economic goods and services
- Differentiate between needs and wants
- Explain concept of supply and demand
- Explain concept of price
- Explain how supply, demand, and price are related
- Explain concept of private enterprise and business ownership
- Explain concept of profit
- Explain concept of risk
- Explain concept of competition
- Explain relationship among risk, competition, and profit
- Describe global economic and world markets
- Describe economic cycles (e.g., unemployment, recession, inflation, budget deficits)
- Describe economic arena's effect on business (e.g., financial, competitor indicators, industry)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Describe economic systems # \***

**Competency Builders:**

Describe free enterprise system

Describe relationship between government and business

Describe relationship between labor and management

Compare types of economic systems

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Understand income statement data # \***

**Competency Builders:**

- Identify revenue
- Identify overhead expenses
- Identify fixed expenses
- Identify direct labor
- Identify indirect labor
- Identify direct and indirect materials
- Identify general and administrative expenses
- Identify selling expenses
- Identify net income

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:** Explain equipment depreciation \*

**Competency Builders:**

- Explain straight line
- Explain sum of year's digits
- Explain declining balance
- Explain IRS strategies

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Identify cost and profit influences \***

**Competency Builders:**

- Explain importance of loss prevention
- Explain importance of maximizing quality
- Explain importance of maximizing productivity
- Differentiate between specialized training and cross training
- Explain labor, management, and government influences on cost /profit
- Explain cost/profit influences of retraining
- Define impact of seasonal business cycles

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:** **Describe economic indicators and trends # A \***

**Competency Builders:**

Define gross national product and gross domestic product

Define national debt

Define impact of interest rates

Define impact of government spending

Define impact of seasonal business cycles

Define impact of inflation, growth, recession, and unemployment

Define impact of national and world events

Define impact of the growth of international trade

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Explain international trade \*

**Competency Builders:**

Describe nature and importance of international trade

Explain marketing in international trade

Explain balance of trade concepts

Describe impact of foreign investment

Describe the influence of national debt

Describe the effect of currency exchange rates on international trade

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Explain basic business concepts \***

**Competency Builders:**

Identify functions of business

Explain role of management

Explain role of labor

Explain concept of service as a product

Explain role of administration

Explain role of operations

Identify role of company objectives

Identify importance of ethical business practices

Identify types of ownership

Identify components of a business plan

Calculate break even and payback

Explain role of depreciation in business decisions

Explain role of capital gains

Describe business reporting and information flow

Map interface of departmental functions

Describe business communication channels (e.g., formal, informal)

Explain basic total quality management (TQM/ISO) principles

Explain the effects of bankruptcy

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Explain legal concepts \***

**Competency Builders:**

Define legal terminology

Explain business law concepts

Identify contracts and/or legal documents

Explain relationship of laws and regulations to company contracts, policies, and procedures

Identify laws relating to working conditions, wages and hours, civil rights, social security, disability, unemployment insurance, and exempt vs. nonexempt

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Explain role of marketing # \***

**Competency Builders:**

- Identify aspects of sound business image
- Explain purposes of marketing
- Describe functions of marketing
- Describe effects of marketing
- Identify target markets
- Define sales potential
- Explain pricing strategies
- Differentiate among advertising campaigns
- Explain functions of advertising agencies
- Describe sales incentive programs
- Differentiate among types of marketing strategies (e.g., phone, mail, person)

# **Unit: Basic Computer Concepts and Applications**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S

**Competency:**      **Describe personal computer operations # \***

**Competency Builders:**

Explain how data is stored in main computer memory

Explain how computer system executes program instruction

Explain computer storage capacity

Explain how data is represented

Describe data storage devices

Identify types of memory

Describe back-up and archival disciplines

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Explain information processing cycle \***

**Competency Builders:**

Describe computer languages and their use (e.g., machine, postscript, proprietary, graphic description)

Describe difference between data files and program files

Explain PC/Mac layout

Explain PC/Mac network layout

Explain mini/mainframe network layout

Differentiate among hardware, software, and firmware

Differentiate between open from proprietary architecture

Explain upload/download

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:** Explain operating systems # \*

**Competency Builders:**

Identify operating systems and their attributes (e.g., DOS, Unix, Macintosh, Windows)

Describe compatibility issues

Identify cross-platform file conversion tools

Describe how commands handle tasks in operating systems

Describe various input/output systems

Describe the purpose of operating system utilities

Differentiate between a compiler and an interpreter

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Demonstrate basic computer literacy # \***

**Competency Builders:**

Create directories/folders and sub-directories

Format disks

Manipulate files (copy, rename, delete)

Keyboard proficiently by touch

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Operate computer hardware # \***

**Competency Builders:**

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)

Identify hardware and its use

Use hardware (e.g., printers, modems, touch screen, digitizers, plotters, graphic tablets, scanners, film recorders, video, laser image setters)

Demonstrate basic care of hardware

Explain need for and application of security levels/procedures

Perform basic hardware troubleshooting

Explain hardware addressing techniques

Maintain usage and maintenance logs

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Explain operation of peripheral devices # \***

**Competency Builders:**

Identify peripherals and operating requirements of each

Identify primary devices used for personal computer auxiliary storage

Describe how data is stored on diskettes and hard drives

List speed and storage capacities of computer auxiliary storage devices

Describe attributes of diskettes and hard disks regarding speed and storage capacity

List types of disk storage used with large computer systems

Define role of tape storage in relation to personal and large computers

Describe security issues related to peripheral devices

Explain purpose of input devices (e.g., keyboard, mouse, scanners, pens, bar code readers, credit/debit/smart cards, voice, video, gloves)

Describe operation of output devices (e.g., voice, speaker output devices, printers, plotters, printer sharing units, SCSI interface, video display)

Describe operation of multimedia (e.g., video, audiosound)

Describe operation of storage devices (e.g., tape, disk, CD-ROM)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	

**Competency:**      **Operate peripheral devices # \***

**Competency Builders:**

- Use appropriate reference materials
- Load media devices
- Start media devices
- Unload media devices
- Import, edit, and export video and audio
- Set up print devices
- Operate scanner devices
- Operate print devices
- Maintain print devices
- Monitor peripheral equipment operations
- Perform routine maintenance on peripheral devices
- List appropriate control procedures
- Transmit via modem
- Receive via modem
- Search a CD-ROM library
- Print information from a CD-ROM library
- Describe device driver

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Store media # \***

**Competency Builders:**

Identify need for data library

Retrieve stored media (e.g., on-line, off-line, permanent, off-site)

File stored media (e.g., on-line, off-line, permanent, off-site)

Initialize media

Catalog media

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Explain software applications # \***

**Competency Builders:**

- Define software types and functions
- Describe need for application software
- Describe different types of software applications
- Explain advantages and disadvantages of integrated and dedicated software
- Differentiate features between like applications
- List software sources
- Explain software copyright laws
- Explain data compression techniques
- Explain use of passwords/security
- Explain desktop productivity tools

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Use word processing packages # \***

**Competency Builders:**

- Define word processing terminology
- Explain functions of word processing software
- Explain word processing applications
- Use appropriate reference materials including on-line help
- Keyboard efficiently by touch
- Use mouse
- Initialize diskette
- Prepare backup file
- Maintain backup file
- Update spelling dictionary and spell check
- Perform document functions (e.g., locate, rename, delete, save, retrieve, copy)
- Perform formatting functions (e.g., center, underline, bold, cut and paste)
- Perform redlining functions
- Use edit features
- Use sort features
- Add page numbers to document
- Add headers and footers
- Print files, pages, screens and blocks of text
- Verify accuracy of output
- Create a document
- Save a document to disk
- Retrieve a document from disk
- Edit an existing document
- Describe word-wrap
- Print a document
- Store boilerplate material (e.g., templates, stationary files)
- Compose documents at keyboard

Tabulate multiple columns  
Prepare new documents from existing ones  
Merge selected copy with new information  
Prepare various types of table options  
Format text  
Integrate database, spreadsheet and graphic files  
Convert documents from one system/version to another  
Demonstrate use of computer thesaurus  
Use multimedia techniques/resources  
Perform merge functions

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	S

**Competency:**      **Use spreadsheet packages # \***

**Competency Builders:**

- Define spreadsheet
- Explain basic spreadsheet terminology
- Define components of spreadsheets
- Describe implementation of spreadsheet operations in business scope
- Use mouse
- Use spell check
- Execute an electronic spreadsheet
- Enter data, formulas, and functions
- Differentiate between labels and numbers
- Speculate using "what if..." questions
- Sequence keystrokes in the creation of a macro
- Create database within spreadsheet
- Perform data query functions
- Move around in spreadsheet and correct errors
- Create links to other files
- Format spreadsheet
- Create graphs
- Print graphs
- Save previously saved files
- Load previously saved files
- Replicate cells using copy commands
- Use electronic spreadsheet to complete business application
- Use spreadsheet to plan financial strategies
- Prepare spreadsheet
- Use multimedia techniques/resources

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C

**Competency:**      **Use databases # \***

**Competency Builders:**

Define database

Explain terms used in database systems

Describe common functions of database systems

Use database to design, create, input, edit, and display fields and records

Analyze structure of database files

Perform calculations with a database file

Alter structure of database file

Sort records based on multiple fields

Identify advanced database technology

Use appropriate reference materials

Utilize relational database

Enter elements into database

Proofread database

Explain database

Design report formats

Import/export data from alternate file formats

Transfer data to and from remote database

Link data to and from remote database

Print reports using data from multiple databases

Use database files with other application software

Verify accuracy of output (e.g., edit reports)

Query databases

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Use graphic user interface (GUI) techniques # \***

**Competency Builders:**

Describe a variety of computer interfaces

Explain multi-tasking environment

Use general navigational skills

Use cut and paste functions

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Manage software packages # \***

**Competency Builders:**

Install software packages

Upgrade software packages

Document installation and upgrade of software packages

Apply security levels/procedures to sensitive data

Manage software preferences

Manage software conflicts

Identify system requirements

Identify licensing issues

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Maintain computer security requirements # \***

**Competency Builders:**

Apply business ethics

Follow security rules, regulations, and codes

Implement security procedures

Document security procedures

Perform security audits

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**            **Maintain personal computer systems # \***

**Competency Builders:**

- Monitor system status and performance
- Run diagnostics, utilities, and anti virus
- Report computer system malfunction(s)
- Report software malfunction(s)
- Identify corrupted files and recovery procedures
- Maintain security
- Maintain hardware/software inventory
- Perform backup procedure(s)
- Perform preventive maintenance
- Demonstrate file management techniques
- Follow log-off and power-down procedure(s)
- Follow equipment maintenance procedures
- Follow quality control procedures

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Demonstrate basic knowledge of networks # \***

**Competency Builders:**

- Explain communications standards
- Describe network structures
- Explain network types and protocols
- Explain network connectivity
- Explain the function of servers in a graphic network
- Describe various network operating systems
- Explain the difference between network software and individual use software
- Use a network to access, file, and store files

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Use a shared environment # \***

**Competency Builders:**

List purposes of a network environment

Define electronic mail

Identify advantages and disadvantages of electronic mail

Describe impact of local & wide area networks on mail delivery

Compose electronic messages

Send electronic messages using appropriate format

List categories of electronic mail service

Transmit document using electronic mail system

Use collaboration tools

Monitor electronic mail

Use networked environments

Search database for properties of materials

Conduct literature searches using a variety of on-line tools

Explain access, security, transmission and retrieval

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Demonstrate knowledge of the Internet/Intranet \***

**Competency Builders:**

Define the Internet/Intranet

Explain how the Internet/Intranet works

Explain Internet/Intranet capabilities and limitations

Explain how to connect to the Internet/Intranet via modem, ISDN, etc.

Install Internet/Intranet software

Navigate the World Wide Web

Identify services and tools offered on the Internet/Intranet

Explain bookmarks

Describe security issues

Describe ethical use of the Internet/Intranet

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Use the Internet/Intranet\***

**Competency Builders:**

Define how the Internet can be used for research

Use services and tools offered on the Internet for research

Identify search engines

Use search engines

Evaluate Internet resources and accuracy of information

Access library catalogs on the Internet

Access commercial and government resources

Download files

Use other Internet/Intranet tools and services

# **Unit: Quality Assurance**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Demonstrate knowledge of quality assurance**

**Competency Builders:**

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)

Explain changes brought about by quality leaders in the world

Explain the ISO 9000 process

Define quality terms

Define quality functions

Identify features of quality planning

Describe control devices used in functional areas (e.g., SPC, equipment)

Explain the relationship among organizational structures, policies, procedures, and quality assurance

Explain importance of internal and external customers

Identify internal and external customers

Describe successful efforts by industry to improve quality and/or reduce costs

Differentiate between prevention and detection

Differentiate between variable and attribute data

Identify types of control charts

Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**      **Demonstrate knowledge of quality cost implications**

**Competency Builders:**

Identify cost/quality objectives

Classify costs (e.g., direct and indirect, fixed and variable, methods and standards)

Classify quality costs (e.g., prevention, evaluation, pre-delivery failure, post-delivery failure)

Define product liability

Interpret quality cost reports

Explain consumerism and liability prevention

Define safety terms of product

Identify safety responsibility within organization

Define contracts and torts

Differentiate between expressed and implied warranty

Differentiate between warranty and product liability

Explain how warranties are part of contract law

List questions that would need answering in liability claim

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Demonstrate knowledge of engineering a quality product**

**Competency Builders:**

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)

Define manufacturability

Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)

Define reliability factors (e.g., cost, human, producibility)

Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)

Explain the relationship of maintainability to reliability

Define failure

Explain the role of testing and reliability

Define value engineering

Define quality objectives

Identify cost components as they relate to quality objectives

Classify quality costs (e.g., preventive, evaluation, pre-delivery failures, post-delivery failures)

Describe predictive maintenance

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Explain importance of interdepartmental relationships to quality assurance**

**Competency Builders:**

Explain need for everyone's commitment in assuring quality

Explain phrase "Everyone is a customer/supplier"

Define quality improvement team models

Explain the importance of top management's support of quality

Explain project selection

Explain project implementation

Explain project evaluation

Explain continuing improvement

Describe future trend of experiment design

Describe future trend of predictive maintenance

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:**      **Manipulate quality cost data**

**Competency Builders:**

Develop quality cost data

Translate cost reports

Graph quality cost data (e.g., pareto)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C

**Competency:** Manipulate cost control data

**Competency Builders:**

Develop cost control data

Analyze cost control reports

Provide cost control data

Provide advice on "Make or Buy" decisions (including economical lot size decisions)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**      **Demonstrate knowledge of basic statistics**

**Competency Builders:**

Describe data collection methods

Collect data

Organize data by flow chart

Interpret data by cause and effect diagrams

Define nominal, ordinal, interval, and ratio data

Define mean, median, and mode

Explain significance of standard deviation

Explain normal distribution

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C

**Competency:** Demonstrate knowledge of scattergrams

**Competency Builders:**

Construct scattergram

Interpret for positive, negative, or no correlation between X and Y variables

Test for significance between one and five percent

Explain regression analysis

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Demonstrate knowledge of probability theory

**Competency Builders:**

Define classical probability

Define empirical probability

Calculate probability for outcomes

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Demonstrate knowledge of precontrol

**Competency Builders:**

Explain uses of precontrol

Calculate precontrol limits

Explain significance of the limits

Plot values on a precontrol chart

Explain "out-of-control" situation

Make decisions on green, yellow and red conditions

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Demonstrate knowledge of process capability

**Competency Builders:**

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)

Calculate estimated process standard deviation

Plot right hand and left hand tail of process variation

Compute Z value for percent of probable defect for process

Calculate  $C_{pk}$  values that describe process capability

Describe skewed distributions

List probable causes of skewed distribution

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Use quality control charts

**Competency Builders:**

Identify operational definitions for attribute criteria

Interpret histogram

Interpret scattergrams

Interpret NP chart

Interpret P chart

Interpret flowchart

Interpret cause-and-effect diagram

Construct P (percentage defective) chart for attributes

Plot control limits of P chart and data points

Check chart for out-of-control conditions

Construct an NP (number defective) chart with control limits and data

Construct C (count of defects) and U (number of defects per unit) charts

Check data on C and U charts

Construct flowchart

Construct cause-and-effect chart

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Interpret X and R charts

**Competency Builders:**

- Plot percentages for normal distribution
- Test distribution for normality
- Explain difference between common cause and special cause
- Define an "in-control" process
- Explain significance of an out-of-control point on X or R chart
- Identify patterns and trends on control chart
- Identify run up and run down
- Test for middle third on control chart
- Explain significance of middle third on control chart
- Explain Rule of Sevens

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Construct X and R charts

**Competency Builders:**

Arrange data into statistical sub-groups

Explain importance of random sampling

Compute X (e.g., average of values) and R (e.g., range of values in subgroup)  
within sample

Plot in X and R on chart

Construct control chart with X (grand average) and R (average range) calculated

Calculate upper and lower control limits for X-chart

Calculate upper and lower control limits for R-chart

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C

**Competency:** Conduct process improvement studies

**Competency Builders:**

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC,  $C_{pk}$ )

Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)

Identify major steps in conducting a study

Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)

Integrate results into the total system

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Demonstrate knowledge of JIT

**Competency Builders:**

Define just-in-time concept (JIT)

Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)

Describe types of inventory control (e.g., Kanban)

Describe importance of flexibility

Differentiate product layout, process layout, fixed position layout, and cellular layout

Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns

Describe advantages/disadvantages of layout and patterns

Explain importance of product protection, identification, and storage

List methods of identifying products (e.g., labels, bar codes, radio frequency systems, and magnetic strip systems)

Describe manual methods of storage and retrieval

Describe automated storage and retrieval systems (ASRS)

Describe automated guided vehicle moving systems (AGVS)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** **Apply JIT**

**Competency Builders:**

Maintain system for physical handling and movement of material in-process and in-storage

Monitor system of physical handling and movement of material in-process and in-storage

Maintain system for physical handling and movement of finished products

Monitor system of physical handling and movement of finished products

Write requests for deviation from specifications

Implement quality control and inspection standards and procedures

Write engineering change notices and rejection reports

Monitor reports of discrepancy or rejects during production process

Conduct quality tests under different environmental conditions

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C

**Competency:** Demonstrate knowledge of inspection

**Competency Builders:**

Explain purpose of inspection

Describe scope of inspection

Explain purpose of incoming, ongoing, and final inspections

Explain early detection inspection

Explain how statistical process control (SPC) aids inspection

Define types of nonconformance

Define degrees of nonconformance

Define corrective action

Describe when to 100% inspect

Describe when to sample inspect

Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)

Define rework, salvage, and scrap

Describe ethical decisions an inspector may make

Identify purposes of computer-automated inspection

Explain advantages and limitations of automated inspection

Explain disposition of non-conforming material

Explain basic foolproofing concept to build inspection into process (e.g., poka-yoke)

Use checksheets to organize and record inspection results

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Inspect machinery, materials, and products

**Competency Builders:**

- Identify critical material characteristics from specification(s) or drawing(s)
- Perform capability studies for machinery and materials acceptance
- Identify appropriate acceptance sampling plan
- Conduct incoming materials inspection using sampling plan criteria
- Identify critical in-process characteristics from specification(s) or drawing(s)
- Demonstrate basic metrology skills
- Conduct in-process inspection
- Identify appropriate inspection reports and follow-up
- Gauge R and R (reproducibility and repeatability)
- Apply geometric tolerancing
- Explain C = O (zero) acceptance plan
- Interpret instructions in a control plan

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Demonstrate knowledge of nondestructive testing

**Competency Builders:**

Describe purpose of nondestructive testing

Identify anomalies

Define defects and discontinuities

Identify factors contributing to defects and discontinuities

Describe ultrasonic testing

Describe advantages and limitations of ultrasonic testing

Describe industrial radiography

Compare use of wet and dry particles in magnetic particle inspection

Explain advantages and limitations of penetrant inspection

Describe microwave testing

Describe holographic inspection

Explain choice of most suitable nondestructive test method

Describe eddy-current testing

## **Unit: Quality Assurance for IM**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Demonstrate knowledge of quality assurance**

**Competency Builders:**

Define quality terms

Define quality functions

Identify features of quality planning

Describe control devices used in functional areas (e.g., SPC, equipment)

Explain importance of internal and external customers

Differentiate between prevention and detection

Differentiate between variable and attribute data

Identify types of control charts

Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Define cost of quality

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Demonstrate knowledge of engineering a quality product**

**Competency Builders:**

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)

Define manufacturability

Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)

Define reliability factors (e.g., cost, human, producibility)

Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)

Explain the relationship of maintainability to reliability

Define failure

Explain the role of testing and reliability

Define value engineering

Define quality objectives

Identify cost components as they relate to quality objectives

Classify quality costs (e.g., preventive, evaluation, pre-delivery failures, post-delivery failures)

Describe predictive maintenance

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Demonstrate knowledge of basic statistics**

**Competency Builders:**

Describe data collection methods

Collect data

Organize data by flow chart

Interpret data by cause and effect diagrams

Define nominal, ordinal, interval, and ratio data

Define mean, median, and mode

Explain significance of standard deviation

Explain normal distribution

Identify sampling techniques

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Demonstrate knowledge of scattergrams**

**Competency Builders:**

Construct scattergram

Interpret for positive, negative, or no correlation between X and Y variables

Test for significance between one and five percent

Explain regression analysis

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate knowledge of precontrol

**Competency Builders:**

Explain uses of precontrol

Calculate precontrol limits

Explain significance of the limits

Plot values on a precontrol chart

Explain "out-of-control" situation

Make decisions on green, yellow and red conditions

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**            **Demonstrate knowledge of process capability**

**Competency Builders:**

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)

Calculate estimated process standard deviation

Plot right hand and left hand tail of process variation

Compute Z value for percent of probable defect for process

Calculate  $C_{pk}$  values that describe process capability and CP

Describe skewed distributions

List probable causes of skewed distribution

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Use quality control charts

**Competency Builders:**

Identify operational definitions for attribute criteria

Interpret histogram

Interpret scattergrams

Interpret NP chart

Interpret P chart

Interpret flowchart

Interpret cause-and-effect diagram

Construct P (percentage defective) chart for attributes

Plot control limits of P chart and data points

Check chart for out-of-control conditions

Construct an NP (number defective) chart with control limits and data

Construct C (count of defects) and U (number of defects per unit) charts

Check data on C and U charts

Construct flowchart

Construct cause-and-effect chart

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Interpret X and R charts

**Competency Builders:**

- Plot percentages for normal distribution
- Test distribution for normality
- Explain difference between common cause and special cause
- Define an "in-control" process
- Explain significance of an out-of-control point on X or R chart
- Identify patterns and trends on control chart
- Identify run up and run down
- Test for middle third on control chart
- Explain significance of middle third on control chart
- Explain Rule of Sevens

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** **Construct X and R charts**

**Competency Builders:**

Arrange data into statistical sub-groups

Explain importance of random sampling

Compute X (e.g., average of values) and R (e.g., range of values in subgroup)  
within sample

Plot in X and R on chart

Construct control chart with X (grand average) and R (average range) calculated

Calculate upper and lower control limits for X-chart

Calculate upper and lower control limits for R-chart

Identify various sampling plans and their use

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Conduct process improvement studies

**Competency Builders:**

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC,  $C_{pk}$ )

Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)

Identify major steps in conducting a study

Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)

Integrate results into the total system

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**            **Demonstrate knowledge of JIT**

**Competency Builders:**

Define just-in-time concept (JIT)

Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)

Describe types of inventory control (e.g., Kanban)

Describe importance of flexibility

Differentiate product layout, process layout, fixed position layout, and cellular layout

Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns

Describe advantages/disadvantages of layout and patterns

Explain importance of product protection, identification, and storage

List methods of identifying products (e.g., labels, bar codes, radio frequency systems, and magnetic strip systems)

Describe manual methods of storage and retrieval

Describe automated storage and retrieval systems (ASRS)

Describe automated guided vehicle moving systems (AGVS)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**      **Apply JIT**

**Competency Builders:**

Maintain system for physical handling and movement of material in-process and in-storage

Monitor system of physical handling and movement of material in-process and in-storage

Maintain system for physical handling and movement of finished products

Monitor system of physical handling and movement of finished products

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**      **Demonstrate knowledge of inspection**

**Competency Builders:**

Explain purpose of inspection

Describe scope of inspection

Explain purpose of incoming, ongoing, and final inspections

Explain early detection inspection

Explain how statistical process control (SPC) aids inspection

Define types of nonconformance

Define degrees of nonconformance

Define corrective action

Describe when to 100% inspect

Describe when to sample inspect

Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)

Define rework, salvage, and scrap

Describe ethical decisions an inspector may make

Identify purposes of computer-automated inspection

Explain advantages and limitations of automated inspection

Explain disposition of non-conforming material

Explain basic foolproofing concept to build inspection into process (e.g., poka-yoke)

Use checksheets to organize and record inspection results

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**            **Inspect machinery, materials, and products**

**Competency Builders:**

- Identify critical material characteristics from specification(s) or drawing(s)
- Perform capability studies for machinery and materials acceptance
- Identify appropriate acceptance sampling plan
- Conduct incoming materials inspection using sampling plan criteria
- Identify critical in-process characteristics from specification(s) or drawing(s)
- Demonstrate basic metrology skills
- Conduct in-process inspection
- Identify appropriate inspection reports and follow-up
- Gauge R and R (reproducibility and repeatability)
- Apply geometric tolerancing
- Interpret instructions in a control plan

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**            **Demonstrate knowledge of nondestructive testing**

**Competency Builders:**

Describe purpose of nondestructive testing

Identify anomalies

Define defects and discontinuities

Identify factors contributing to defects and discontinuities

Describe ultrasonic testing

Describe advantages and limitations of ultrasonic testing

Describe industrial radiography

Compare use of wet and dry particles in magnetic particle inspection

Explain advantages and limitations of penetrant inspection

Describe microwave testing

Describe holographic inspection

Explain choice of most suitable nondestructive test method

Describe eddy-current testing

## **Unit: Technical Recording and Reporting**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Demonstrate proficiency in technical recording**

**Competency Builders:**

- Describe various documentation procedures
- Interpret specifications or drawings
- Observe process
- Ask open-ended questions
- Record process (e.g., flowchart, step-by-step)
- Identify parameters
- Record accurate, truthful data
- Maintain test logs
- Compile cumulative reference notebook/record
- Measure appropriate parameters
- Draft preventive maintenance and calibration procedures

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**            Demonstrate proficiency in technical reporting

**Competency Builders:**

Use data books and cross reference/technical manuals

Compose technical memoranda

Identify type of report or format needed

Use appropriate format

Compile relevant data

Design charts and graphs

Analyze data

Draw conclusions

Explain analytical methods used

Outline reports

Write reports

Present reports

# **Unit: Supervision**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Perform supervisory functions

## **Competency Builders:**

- Define supervision
- Conduct task analysis
- Create organizational and/or departmental charts
- Apply company policies and procedures
- Maintain workplace procedures manuals
- Prepare budgets
- Monitor budgets
- Prepare managerial reports
- Analyze daily production reports
- Identify human resources needed
- Maintain appropriate work environment
- Conduct tours
- Facilitate assignments
- Assign work
- Delegate job tasks
- Monitor progress
- Prepare productivity reports
- Provide training for new policies
- Troubleshoot workplace problems
- Coordinate workplace activities
- Appraise performance
- Document personnel issues
- Coordinate administrative duties

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:** Coordinate training

**Competency Builders:**

- Assess training needs
- Secure training resources, materials and equipment
- Train employees
- Evaluate progress of trainee
- Provide feedback
- Solicit feedback
- Receive feedback
- Assess feedback
- Monitor safety procedures
- Interpret labor contracts
- Document training

## **Unit: Drafting Technology for IM and CT**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      **Apply basic drafting skills**

### **Competency Builders:**

Use drafting equipment

Identify line types (alphabet of lines)

Select proper drawing scale, introduction to different types

Prepare title blocks and other drafting formats

Apply freehand and other lettering techniques

Prepare multi-view drawings

Prepare multi-view sketches

Prepare orthographic views

Prepare change control/revision block

Describe change control block/revision block

Measure angles

Draw horizontal, vertical, angular, parallel, and perpendicular lines

Transfer an angle

Construct tangent lines (to arcs) and tangent arcs (to arcs)

Bisect angles and arcs

Bisect lines

Divide lines

Construct three-point circle

Construct regular hexagon, pentagon, and octagon

Reproduce a drawing

Prepare single-view drawings

Prepare working drawings

Interpret notes and dimensions to determine part  
Draw arcs, circles, and conics  
Transfer measurements  
Identify current ANSI symbols/standards

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      **Apply intermediate drafting skills**

**Competency Builders:**

Describe types of media and prints

Apply isometric, oblique, and perspective sketching techniques

Prepare isometric, oblique, and perspective sketches

Prepare sectional views

Prepare auxiliary views

Prepare views of drilled and tapped holes, counterbores, countersinks

Apply systems drafting techniques

Identify a bill of materials

Describe purpose of auxiliary and sectional views

Dimension drawings per current ANSI standards

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	

**Competency:**      **Apply advanced drafting skills**

**Competency Builders:**

Interpret reports and specifications

Prepare pictorial drawings

Prepare schematics

Interpret various drawings

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	

**Competency:**            **Interpret basic prints**

**Competency Builders:**

- Visualize object from drawing
- Interpret orthographic projections
- Interpret isometric views
- Interpret sectional views
- Interpret detail and assembly drawings
- Interpret dimensions
- Interpret tolerances

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      Interpret advanced prints

**Competency Builders:**

Interpret screw thread specifications

Identify structural steel shapes

Interpret special symbols

Interpret electrical, pneumatic/hydraulic drawings

Interpret schematics

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

**Competency Builders:**

Identify geometric characteristics and symbols (e.g., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)

Define maximum material condition

Define least material condition

Define regardless of feature size condition

Describe feature control blocks

Describe datum surfaces and targets

Define flatness (pitch)

Define straightness (yaw)

Define roundness

Define cylindrically

Define profile of line

Define profile of surface

Define perpendicularity

Define angularity

Define parallelism

Define circular runout

Define total runout

Define true position concept to determine tolerance for location of holes in mating parts

Interpret GD&T characteristic symbols

Interpret GD&T supplementary symbols

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      Convert dimensions and tolerances

**Competency Builders:**

Convert dimensions and tolerances from English units to metric units

Convert dimensions and tolerances from metric units to English units

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Apply revision control process**

**Competency Builders:**

Apply drawing balloons

Apply documentation (including project filing, back-up material, tracking process)

Apply change control block

Apply revision levels

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      **Demonstrate dimensioning techniques**

**Competency Builders:**

Construct arrowheads using various styles/disciplines

Apply symbols for surface and texture control

Add labels/notes to drawing

Dimension arcs

Dimension angles

Dimension curves

Dimension rounded-end shapes

Dimension spherical objects

Dimension cylindrical objects

Dimension cones, pyramids, and prisms

Dimension features on circular center line

Dimension theoretical point of intersection

Dimension object using rectangular coordinate system

Dimension object using polar coordinate system

Dimension object using tabular coordinate system

Dimension object using ordinate dimensioning system

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Apply geometric dimensioning and tolerancing**

**Competency Builders:**

- Interpret decimal tolerance dimensions
- Calculate clearance fit tolerances of mating parts
- Dimension clearance fit tolerances of mating parts
- Calculate interference fit tolerances of mating parts
- Dimension interference fit tolerances of mating parts
- Calculate tolerances to mating parts using standard fit tables
- Assign tolerances to mating parts using standard fit tables
- Apply positional and form tolerancing symbols
- Apply symbols for true position
- Interpret geometric dimensioning and tolerancing characteristic symbols
- Interpret geometric dimensioning and tolerancing supplementary symbols
- Apply symbols for maximum material control regardless of feature size
- Calculate effects of dimensional stack-up
- Calculate transitional fit tolerances
- Dimension transitional fit tolerances

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Prepare mechanical drawings**

**Competency Builders:**

Interpret basic mechanical standards and symbols

Prepare assembly drawings

Prepare welding drawings

Prepare bearing drawings

Prepare casting drawings

Prepare forging drawings

Prepare tool drawings

Prepare molding diagrams

Prepare drawings with special processed holes

Prepare stamping drawings

Prepare numerical control drawings/instructions

Prepare installation drawings

Prepare purchase part drawings

Prepare approval drawings

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Prepare advanced mechanical drawings**

**Competency Builders:**

Resolve problems by descriptive geometry and revolutions

Use precision dimensioning to include geometric characters

Use precision measuring instruments (e.g., calipers)

Prepare fastener drawings

Prepare cam drawings

Prepare gear drawings

Prepare spring drawings

Prepare pulley and chain drive drawings

## **Unit: Drafting Technology for ET and EM**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**      **Apply basic drafting skills**

### **Competency Builders:**

Use drafting equipment, measuring scales, drawing media, drafting instruments and materials, print duplicating equipment

Identify line styles, weights (alphabet of lines)

Select proper drawing scale, introduction to different types

Prepare title blocks and other drafting formats

Apply freehand and other lettering techniques

Prepare multi-view drawings

Prepare multi-view sketches

Prepare orthographic views

Prepare change control block/revision block

Describe change control block/revision block

Measure angles

Draw horizontal, vertical, angular, parallel, and perpendicular lines

Transfer an angle

Construct tangent lines (to arcs) and tangent arcs (to arcs)

Bisect angles and arcs

Bisect lines

Divide lines

Construct three-point circle

Construct regular hexagon, pentagon, and octagon

Reproduce a drawing

Prepare single-view drawings

Prepare dimension drawings

Interpret notes and dimensions to determine part

Draw arcs, circles, and conics

Transfer measurements

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      **Interpret basic prints**

**Competency Builders:**

- Visualize object from drawing
- Interpret orthographic projections
- Interpret isometric views
- Interpret sectional views
- Interpret detail and assembly drawings
- Interpret dimensions
- Interpret tolerances

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Interpret intermediate prints**

**Competency Builders:**

Interpret screw thread specifications

Identify structural steel shapes

Interpret special symbols

Interpret electrical, pneumatic/hydraulic drawings

Interpret schematics

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Convert dimensions and tolerances

**Competency Builders:**

Convert dimensions and tolerances from English units to metric units

Convert dimensions and tolerances from metric units to English units

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Demonstrate dimensioning techniques

**Competency Builders:**

Construct arrowheads using various styles/disciplines

Apply symbols for surface and texture control

Add labels/notes to drawing

Dimension arcs

Dimension angles

Dimension curves

Dimension rounded-end shapes

Dimension spherical objects

Dimension cylindrical objects

Dimension cones, pyramids, and prisms

Dimension features on circular center line

Dimension theoretical point of intersection

Dimension object using rectangular coordinate system

Dimension object using polar coordinate system

Dimension object using tabular coordinate system

Dimension object using ordinate dimensioning system

Interpret decimal tolerance dimensions

Calculate effects of dimensional stack-up

## **Unit: Visualization and Design for Function**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:** Deduce by examination function(s) of parts

### **Competency Builders:**

Identify through examination the function of parts related to an automobile

Identify through examination the function of parts related to machine tools

Identify through examination the function of parts related to personal computers

Explain how function is related to part properties (e.g., geometry, material, finish)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Design/prepare computer model objects for function**

**Competency Builders:**

- Develop an alternative design for an existing automobile part
- Develop an alternative design for an existing machine tool part
- Develop an alternative design for an existing computer part
- Prepare a computer model of a house, warehouse, or other building
- Prepare a computer model of a manufacturing process

## **Unit: CADD Fundamentals**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:** Demonstrate basic use of computer operating system

### **Competency Builders:**

- Explain rules for naming files and directories
- Manage files
- Create directories/subdirectories
- Remove directories/subdirectories
- Change directories/subdirectories
- Copy files
- Rename files
- Erase files
- Format diskettes
- Label diskettes
- Explain the syntax of operating system commands
- Use wildcards in operating system commands

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C

**Competency:**            **Operate a CADD system**

**Competency Builders:**

- Use keyboard input
- Use screen and tablet menus
- Use other input devices (e.g., scanner, digitizer, mouse)
- Create scaled plots
- Operate a printer/plotter (e.g., laser plotter)
- Access on-line help for commands
- Use file conversion
- Use data transfer

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      **Select entities for action**

**Competency Builders:**

Add or remove entities separately

Add or remove entities using a window

Add or remove entities with a crossing-box

Select entities using a fence

Select entities by other methods (e.g., last, previous, type, all)

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**            **Create 2-D orthographic drawings**

**Competency Builders:**

Create primitive drawing entities

Draw utilizing absolute Cartesian coordinates

Draw utilizing relative Cartesian coordinates

Draw utilizing polar coordinates

Draw using construction aides (e.g., snaps, grid, snap)

Change drawing attributes

Edit drawing entity properties (e.g., color, layer, thickness, linetype)

Construct drawing entities (e.g., offset, timer, extend, break, mirror)

Edit drawing entities (e.g., offset, trim, extend, break, mirror)

Set system variables (e.g., units, scale)

Use system variables

Create layers

Name layers

Manipulate layers

Save files

Create back-ups

Create hatches, patterns, symbols

Recall drawing templates/blocks

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Annotate orthographic drawings**

**Competency Builders:**

Create text styles

Edit text styles

Select text styles

Apply notes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,M

**Competency:**      Dimension orthographic drawings

**Competency Builders:**

Apply dimensions per standards

Edit text

Control dimension variables/models

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      Control display

**Competency Builders:**

Apply view control while drawing (e.g., zoom and pan)

Control view resolution (e.g., viewers)

Save views

Display views

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      Extract entity and drawing information

**Competency Builders:**

Measure distances

Measure areas

Identify locations

List entity characteristics (e.g., length, size, location, properties)

## **Unit: Intermediate CADD**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Manage symbols and attributes**

**Competency Builders:**

- Create blocks/cells/templates
- Create nested blocks/templates/cells
- Insert blocks and drawings/templates/cells
- Redefine blocks/templates/cells
- Edit blocks/templates/cells
- Create/apply/modify attributes

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**              Create 2-D isometric drawings

**Competency Builders:**

Explain isometric projection

Manipulate isometric snap and grid settings

Toggle isometric planes (e.g., left, right, top)

Create text styles for each plane

Create dimension styles

Create isometric ellipses

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Use external/internal routines**

**Competency Builders:**

- Load AutoLISP programs
- Execute AutoLISP programs
- Export CAD files
- Import CAD files
- Export text/graphic files
- Import text/graphic files

## **Unit: Advanced CADD**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

**BIL:** Essential

EDU:	12	AD	AC
	I	P	M

**Competency:** Create 3-D solid models

### **Competency Builders:**

Differentiate B-rep solid modeling and Constructive Solid Geometry (CSG) modeling

Create solid primitives

Modify solid primitives

Create swept solids

Use Boolean operations to create complex solids (e.g., unions, subtractions, intersections, separations)

Fillet solid models

Chamfer solid models

Extract mass properties from a solid model

Create 2-D profiles and sections from a solid model

Explain the limitations of solid modeling

List intersection properties

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Apply advanced display control**

**Competency Builders:**

Use clipping planes to section a model

Apply perspective views

Place camera and target points to locate views

Place lights for rendering

Control lights for rendering

Create rendered images of surface and solid models

Define camera viewpoints and angle of rotation

Control display angle (e.g., d-view, v-point)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
		I	M

**Competency:** Write CADD sub-routines

**Competency Builders:**

Perform simple math functions

Perform nested math functions

Write a routine which prompts for user input, performs calculations, and creates or edits geometry

Identify common error codes

Format a program to display balanced parentheses and nesting of functions

Write a program including an "if/then/else" statement

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**      **Configure a CADD station**

**Competency Builders:**

Install CADD software

Configure display drivers

Configure printer/plotter drivers

Configure input drivers

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Prepare electrical/electronic CADD drawings**

**Competency Builders:**

Interpret basic electric/electronic standards and symbols

Prepare schematic drawings

Prepare cable drawings

Prepare component drawings

Prepare logic diagrams

Prepare control panel drawings

Prepare connection drawings

Prepare interconnection drawings

Prepare printed circuit board drawings

Prepare harness drawings

Prepare packaged drawings

Prepare wiring diagrams

Prepare enclosure drawings

Prepare installation drawings

Prepare flow charts

Prepare symbol library

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**            **Prepare pneumatic/hydraulic CADD drawings**

**Competency Builders:**

Interpret basic pneumatic/hydraulic standards and symbols

Prepare piping drawings

Prepare isometric drawings

Prepare sectional diagrams

Prepare graphical symbols

Prepare process and instrumentation diagrams

Prepare combination diagrams

Prepare pump and motor drawings

Prepare cylinder and piston diagrams

Prepare valve drawings

Prepare pump section drawings

Prepare installation drawings

Prepare symbol library

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**            **Prepare structural CADD drawings**

**Competency Builders:**

- Use structural and reinforcing concrete manuals and technical tables
- Detail structural beam connections
- Detail concrete reinforcements
- Prepare materials take off list
- Draw structural framing plans and elevations
- Identify welding symbols
- Prepare symbol library

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
		I	

**Competency:** Create custom menus and linetypes

**Competency Builders:**

- Demonstrate search routines when using a text editor
- Write screen menus and macros
- Write tablet menus and macros
- Write cascading pop-down menus and macros
- Write icon menus and macros
- Write button menus and macros
- Write other customizable CADD files (e.g., ACADD.PCP)
- Edit other customizable CADD files (e.g., ACADD.PCP)
- Formulate custom linetype
- Formulate a linetype composed of long dashes
- Formulate a linetype composed of lines, dashes, and dots

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Create 3-D models**

**Competency Builders:**

Differentiate between extrusions, wireframes, surface models, and solid models

Create user coordinate systems

Manipulate user coordinate systems

Use cylindrical coordinates

Use spherical coordinates

Use .XYZ filters

Project geometry from one plane to another

Define B-rep surfaces

Differentiate B-rep surfaces and non-uniform rational B-splines (NURB's)

Create tabulated surfaces

Create ruled surfaces

Create revolved surfaces

Create edge surfaces (e.g., coon's patch)

Apply surface meshes to 3-D wireframes

Modify visibility of the edges of faces

Dimension a 3-D model for both isometric and orthographic drawings

Control dimension scale with regard to plotting scale

## **Unit: Basic Electricity**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	S,M,C

**Competency:** Demonstrate proficiency in electrical fundamentals

### **Competency Builders:**

- Identify electronic components and schematic symbols
- Describe basic atomic structure and its relationship to electricity
- Describe the relationship between electrical and magnetic properties
- Describe the electrical and magnetic properties of a magnet
- Describe the photoelectric effect
- Describe the thermocouple and Peltier effects
- Describe the electrical effect of friction
- Use metric units to solve electronic unit problems
- Identify sources of electricity
- Describe principles and operations of electrochemical supplies
- Describe voltage, current, resistance, power, and energy
- Apply Ohm's Law
- Apply Kirchhoff's Laws
- Apply power formulas
- Explain Thevenin's Theorem
- Explain Norton's Theorem
- Interpret color codes and symbols to identify electrical components and values
- Measure properties of circuits using test equipment
- Demonstrate electrostatic discharge (ESD) preventative procedures

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,S,C

**Competency:**      **Demonstrate proficiency in DC circuits**

**Competency Builders:**

Compute conductance of conductors and insulators

Measure resistance and current of conductors and insulators

Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)

Build series, parallel, and combination circuits

Build bridge circuits

Build voltage divider circuits (loaded and unloaded)

Compute voltage divider circuits (loaded and unloaded)

Demonstrate maximum power transfer theory

Describe magnetic properties of circuits and devices

Explain physical and electrical characteristics of capacitors and inductors

Describe RC and RL time constants

Compute RC and RL time constants

Operate power supplies for DC circuits

Use meters and oscilloscopes

Measure current, voltage, and resistance in DC circuits

Explain simple DC generator action

Explain simple DC motor action

Explain principles of solid-state switching devices

Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)

Identify classes, voltage ratings and/or polarity of electronic components

Identify use of circuit protective devices (e.g., fuses, breakers)

Troubleshoot DC circuits

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate proficiency in AC circuits**

**Competency Builders:**

Analyze properties of an AC signal

Describe principles and operational characteristics of sinusoidal and non-sinusoidal wave forms

Identify AC sources

Describe principles and operational characteristics of capacitive circuits

Operate capacitive circuits

Describe principles and operational characteristics of inductive circuits

Operate inductive circuits

Describe principles and operation of transformers

Demonstrate operation of AC circuits utilizing transformers

Use Thevenin's and Norton's theorem to analyze AC circuits

Measure power in AC circuits

Operate capacitor and inductor analyzers for AC circuits

Operate differentiators and integrators to determine RC and RL time constants

Describe principles and operational characteristics of series and parallel resonant circuits

Build series and parallel resonant circuits

Identify classes, voltage, ratings, and/or polarity of electronic components

Identify use of circuit protective devices (e.g., fuses, breakers)

Describe principles and operational characteristics of frequency selective filter circuits

Calculate gain (dB) using logarithmic tables or calculator/ computer

Operate frequency selective filter circuits

Operate polyphase circuits

Describe basic motor theory and operation

Describe basic generator theory and operation

Operate power supplies for AC circuits

Describe principles and operation of various power conditioning systems (e.g., isolation transformers, surge suppressors, uninterruptable power systems)

Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters)

Describe characteristics of inductors in series and parallel circuits

Describe characteristics of capacitance in series and parallel circuits

Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)

Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal

Describe frequency (f) and phase relationships

Describe resonance of inductive-capacitive (LC) circuits

Calculate impedance match and maximum transfer of power

Measure current, voltage, and resistance in AC circuits

Explain simple AC generator action

Explain simple AC motor action

Calculate Power Factor in AC circuits

Explain Power Factor correction in reactive loads

Explain harmonics and its effects on power quality

Solve basic trigonometric problems as applicable to electronics

Calculate peak (PK), root mean square (RMS), and average values

Troubleshoot AC circuits

## **Unit: Fundamentals of Electronics Technology**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Demonstrate proficiency in discrete solid-state devices**

### **Competency Builders:**

- Describe properties of semiconductor materials
- Describe operating characteristics and applications of PN junctions
- Demonstrate operation of diode circuits
- Troubleshoot diode circuits
- Repair diode circuits
- Describe operating characteristics and applications of bipolar transistors
- Describe operating characteristics and applications of field effect transistors (e.g., FET + s/MOSFET + s)
- Describe operating characteristics and application of special diodes/transistors
- Describe operating characteristics and applications of opto-electronic devices (e.g., gate isolators, interrupt sensors, infrared sensors)
- Describe operating characteristics and applications of single-stage amplifiers
- Demonstrate the operation of the single-stage amplifiers
- Troubleshoot single-stage amplifiers
- Repair single-stage amplifiers
- Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC)
- Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC)
- Operate power supplies for solid-state devices
- Operate oscilloscopes for solid-state devices
- Operate function generators for solid-state devices
- Operate curve tracers
- Operate transistor testers

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,S,M

**Competency:** **Describe manufacturing of electronic devices and micromechanisms**

**Competency Builders:**

List properties of electronic packaging materials

Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits

Describe joining and assembly of electronic components

Describe coating and etching processes

List principles of packaging electronic components

Describe manufacture of miniature devices

Describe testing of joints

Describe reliability of electronic product testing

Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)

Describe methods of fabrication

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Distinguish between analog and digital phenomena and circuits**

**Competency Builders:**

Describe the analog and digital measurement techniques of physical parameters  
(e.g., temperature, time, current, number of items coming down a production line)

Distinguish between an analog and a digital clock

Describe the instruments used to measure analog signals

Describe the instruments used to measure analog digital signals

Describe how an analog signal can be converted to a digital signal

Describe how an digital signal can be converted to an analog signal

## **Unit: Electronic Noise**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Identify sources of electronic noise**

**Competency Builders:**

- Define and explain intrinsic noise sources
- Define and explain active and passive device noise
- Explain conductively coupled noise
- Explain common impedance noise coupling
- Explain noise coupling by electric and magnetic fields

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      Explain how to measure electronic noise

**Competency Builders:**

Explain the use of "The Decibel" in noise characterization

Explain the standard "Noise Units" and weighing functions

Explain signal to noise ratios

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Explain techniques used to reduce electronic noise**

**Competency Builders:**

Explain noise reduction at the source

Explain noise coupling reduction

Explain noise reduction at the "Receiver"

Explain grounding techniques

Explain shielding techniques

Explain opto-electric isolation

## **Unit: Analog Circuits**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      Explain linear power supply regulator circuits

### **Competency Builders:**

Explain the need for voltage and current regulation

Explain how a fast linear regulator can reduce ripple

Define the output impedance of both an ideal and a practical voltage regulator

Define the output impedance of both an ideal and a practical current regulator

Explain how the linear voltage regulator can be made adjustable

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**      **Describe linear power amplifiers**

**Competency Builders:**

Define a linear amplifier

Explain the use and operation of D.C. servo motor drivers

Explain the use and operation of audio power amplifiers

Explain what is meant by the bandwidth of power amplifiers

Explain the transient response of power amplifiers

Explain phase distortion in power amplifiers

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:**      **Describe operational amplifiers**

**Competency Builders:**

Explain the significance of high open circuit gain

Explain the significance and characteristics of the summing junction

Explain offset and its adjustment

Explain the significance of differential inputs

Explain the unity gain buffer and line driver

Explain the analog voltage adder/subtractor

Describe/implement a current amplifier

Describe/implement a charge amplifier

Describe/implement an integrator

Define integrator "wind up"

Explain why "reset" is necessary in an integrator

Describe/implement a differentiator

Describe/implement a single pole low pass filter

Prepare a Bode plot for a single pole low pass filter

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Describe instrumentation amplifiers**

**Competency Builders:**

Explain how an instrumentation amplifier differs from a simple operational amplifier

Describe the signal types, levels, and environments that require instrumentation amplifiers for signal processing

Explain the significance of balanced input impedance

Demonstrate how an instrumentation amplifier can be constructed from operational amplifiers

Describe the characteristics of the resistors needed to make an instrumentation amplifier from an operational amplifier

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**      **Describe analog active filters**

**Competency Builders:**

Describe need and uses of electronic active filters

Describe a single pole low pass filter

Describe a single pole high pass filter

Describe a band pass filter

Describe multi-pole low pass filters

## **Unit: Digital Logic Circuits**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:** **Use binary arithmetic**

### **Competency Builders:**

- Identify features of positional numbering systems
- Identify mathematical forms of notation
- Perform number system conversions (e.g., binary to decimal, octal to binary)
- Perform binary mathematical operations (e.g., addition, subtraction)
- Use coded systems (e.g., BCD-Binary Coded Decimal)
- Demonstrate binary code for decimal numerals 0-9

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      **Use Boolean algebra**

**Competency Builders:**

Explain basic functions of Boolean algebra

Identify signal levels that represent Boolean algebra

Perform Boolean operations

Write Boolean theorems

Draw light switching schematic circuits for OR, AND, NOT and exclusive OR

Draw logic diagrams For OR, AND, NOT, exclusive OR

Draw truth tables for OR, AND, NOT, and exclusive OR

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      Explain digital logic elements

**Competency Builders:**

Differentiate between types of digital logic families

Describe digital logic gates, AND, OR, NOT

Describe R-S (Reset-Set) flip-flops

Describe J-K clocked flip-flops

Describe shift registers

Describe encoders and decoders

Describe the binary full adder

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M

**Competency:**      **Explain digital logic and pulse circuits**

**Competency Builders:**

Implement the exclusive OR circuit using AND, OR, and NOT gates

Describe digital counters

Describe digital clocks and timers

Describe the schmidt trigger

Describe the monostable (single shot) multivibrator

Describe the astable (free running) multivibrator

## **Unit: Microcomputer Electronics Technology**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic proficiency in microcomputer systems**

### **Competency Builders:**

- Describe essential components of microcomputers and their functions
- Describe principles and operation of BUS concepts (e.g., VESA, EISA)
- Describe principles and operation of types of memory circuits
- Identify operating systems (e.g., DOS, OS/2, UNIX)
- Describe microprocessor instructions sets
- Describe principles and operation of microprocessor machine code
- Demonstrate use of microprocessor machine code
- Disassemble microprocessor machine code
- Identify types of input and output devices and peripherals
- Describe principles and operation of storage devices
- Interface input and output ports to peripherals
- Demonstrate ability to interface peripherals
- Identify central processing unit building blocks and their uses
- Identify the levels of computer languages

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Demonstrate basic proficiency in computer systems architecture**

**Competency Builders:**

- Describe the principles and operation of computer system architecture
- Operate computer system architecture
- Repair computer system architecture
- Describe the principles and operation of addresses and interrupts
- Describe the principles and operation of volatile and non-volatile memory
- Demonstrate the use of volatile and non-volatile memory
- Repair or replace volatile and non-volatile memory
- Describe the principles and operation of advanced memory techniques
- Define individual system blocks
- Draw systems configuration in block detail
- Interpret computer acronyms
- Describe priorities and interrupts at systems level
- Identify direct memory access data handling system(s)
- Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
- Troubleshoot a microcomputer system

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Demonstrate proficiency in software fundamentals**

**Competency Builders:**

- Load operating system software
- Run operating system software
- Load diagnostic software
- Run diagnostic software
- Construct flow charts
- Analyze flow charts
- Explain computer languages and their uses
- Write a simple computer program
- Write program documentation
- Describe firmware applications
- Identify the need for backup
- Describe security measures
- Describe virus protection

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Describe elements of communication interfacing**

**Competency Builders:**

Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485, IEEE 488)

Identify sync devices

Identify async devices

Identify types of network (e.g., token ring, ethernet)

Identify networking levels or layers

Identify protocols

Identify packet switching

Identify multiuser systems

Operate network analyze devices

Identify network analyzer devices (e.g., breakout box, sniffers)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:** **Describe peripheral equipment interfaces**

**Competency Builders:**

Define printer types and interface controllers

Explain the operation of typical magnetic tape equipment and interface controllers

Identify disk equipment and interface controllers

Define environmental requirements for peripherals and media

# **Unit:      Instrumentation Control Technology**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,C,M

**Competency:**      **Describe instrument loops**

**Competency Builders:**

Use Instrumentation Society of America (ISA) symbology

Describe types of transducers (e.g., flow, level, pressure, temperature)

Describe transducer signal types and levels

Describe elements of a control loop (e.g., transmitter, indicator, controller, transducer, control valve)

Describe modes of control operation (e.g., manual, automatic, cascade, program)

Describe details of flow loop (e.g., orifice plate, segmental wedge, differential pressure transmitters (electronic and pneumatic), magnetic, turbine type transmitters, local indicators, controller, transducer, control valve)

Describe types of transducers used in level control loops

Describe details of pressure transducers

Describe details of temperature transducers (thermocouples and thermistors)

Describe details of infrared and photosensors

Describe details of proximity/vibration sensors

Describe details of speed/acceleration sensors

Describe details of resolvers and encoders

Describe details of linear voltage detection transformers (LVDT)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Calibrate loop elements**

**Competency Builders:**

- Identify manufacturer's requirements
- Identify loop requirements
- Verify function of test equipment
- Set up test procedure
- Perform calibration
- Record results

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Build control loops**

**Competency Builders:**

- Build flow loop
- Build level control loop
- Build pressure loop
- Build temperature loop

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:** Perform calculations

**Competency Builders:**

Calculate orifice plate sizing

Calculate flow transmitter differential pressure

Calculate control valve sizing

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C,S

**Competency:**      **Describe distributed control systems**

**Competency Builders:**

Describe various types of Input/Output (I/O) Signals

Describe various types of alarms

Describe system architecture

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:**      **Describe types of controller action**

**Competency Builders:**

Describe proportional control action (P)

Describe proportional and integral control action (PI)

Describe proportional, integral, and derivative control action (PID)

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**            **Perform loop tuning**

**Competency Builders:**

Troubleshoot loops

Demonstrate effect of using only a proportional parameter

Demonstrate effect of using only proportional and integral parameters

Demonstrate effect of various values for proportional, integral, and derivative tuning parameters

Demonstrate loop training using "open loop" step testing

Demonstrate loop tuning using Ziegler Nichols method

# **Unit:      Electro-optic Technology**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      **Demonstrate knowledge of light principles**

**Competency Builders:**

Describe the characteristics of light sources

Describe radiometric and photometric quantities in the measurement of light using light meters and related equipment

Describe the properties of light

Demonstrate the properties of light

Describe maximum permissible exposure (MPE)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      **Demonstrate knowledge of optical systems**

**Competency Builders:**

Describe the characteristics and properties of optical materials

Describe the use of optical components (e.g., lenses, beam splitters)

Describe the principles and operation of optical systems (e.g., ray tracing, refraction)

Demonstrate the use of optical systems (e.g., convergence, focusing, divergence)

Troubleshoot optical systems

Describe the advantages and disadvantages of fiber optics

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      Demonstrate knowledge of lasers

**Competency Builders:**

Describe the principles of laser operations (e.g., population inversion, coherence)

Describe laser classifications

Describe the principles and operation of powering and pumping lasers

Describe temporal characteristics

Describe spatial characteristics

Describe laser safety

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S

**Competency:** **Describe laser energy applications**

**Competency Builders:**

Describe the principles and operation of ion lasers

Describe the principles and operation of solid lasers

Describe the principles and operation of semiconductor lasers

Describe the principles and operation of dye lasers

Describe the principles and operation of lasers in welding, cutting, and drilling

Describe the principles and operation of lasers in data recordings and manipulating

Describe the principles and operation of lasers in environmental testing and monitoring

Describe the principles and operation of lasers in nondestructive testing

Describe the principles and operation of lasers in range finding, alignment and angle testing

Describe the principles and operation of fiber optics in laser systems

Describe the principles and operation of a laser in a communication system

Describe the advantages and disadvantages of fiber optics

Describe the principles of using lasers in medicine

Describe the principles of using lasers in holography/ interferometry

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S

**Competency:** Perform laser applications

**Competency Builders:**

- Demonstrate the operation of various ion lasers
- Demonstrate the operation of solid lasers
- Demonstrate the operation of semiconductor lasers
- Demonstrate the operation of dye lasers
- Demonstrate CW and pulsed operation
- Demonstrate the use of lasers in welding, cutting, and drilling
- Demonstrate the use of lasers in data recording and manipulating
- Demonstrate the use of lasers in environmental testing and monitoring
- Demonstrate the use of lasers in nondestructive testing
- Demonstrate the use of lasers in range finding, alignment, and angle testing
- Demonstrate the use of a laser communication system
- Troubleshoot laser applications
- Repair laser applications

## **Unit: Electronics Troubleshooting and Repair**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate troubleshooting skills**

**Competency Builders:**

- Explain role of preventive maintenance
- Differentiate normal and abnormal operations
- Explain troubleshooting procedures
- Explain logical actions taken to troubleshoot
- Identify and use proper troubleshooting aids and tools
- Demonstrate knowledge of safety rules for troubleshooting and repair procedures
- Maintain troubleshooting and repair records
- Interpret prints
- Use manufacturer's manuals, schematics, and troubleshooting charts
- Isolate faults, shorts, and open circuits
- Explain techniques for identifying thermal failures

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**      **Apply troubleshooting and repair techniques to DC circuits**

**Competency Builders:**

Identify noise problems

Isolate faults in series, parallel and series parallel

Isolate faults in bridge circuits

Isolate faults in DC power supplies

Perform polarity check

Repair faults

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Apply troubleshooting and repair techniques to AC circuits**

**Competency Builders:**

Isolate faults in capacitive circuits

Isolate faults in inductive circuits

Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)

Isolate faults in RC, RL, and RLC circuits

Isolate faults in frequency selective filter circuits

Repair faults

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Apply troubleshooting and repair techniques in discrete solid-state devices**

**Competency Builders:**

Isolate faults in diode circuits

Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)

Isolate faults in transistor circuits

Isolate faults in operational amplifier circuits

Repair faults

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Apply troubleshooting and repair techniques to analog circuits**

**Competency Builders:**

- Isolate faults in single and multistage amplifiers
- Isolate faults in audio power amplifiers
- Isolate faults in regulated and switching power supply circuits
- Isolate faults in active filter circuits
- Isolate faults in oscillator circuits
- Isolate faults in power supplies (loaded and unloaded) and filters
- Repair faults

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      **Apply troubleshooting and repair techniques to digital circuits**

**Competency Builders:**

Identify noise problems

Isolate faults in multiplexer and demultiplexer circuits

Isolate faults in digital display circuits

Isolate faults in logic gates

Isolate faults in flip-flops

Isolate faults in registers and counters

Isolate faults in clock and timing circuits

Isolate faults in arithmetic-logic circuits

Isolate faults in encoders and decoders

Isolate faults in digital-display devices

Repair faults

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Apply troubleshooting and repair techniques to a microcomputer system**

**Competency Builders:**

- Isolate faults to systems boards
- Isolate faults to memory circuits
- Isolate faults to data storage devices
- Isolate faults in power supplies
- Troubleshoot I/O ports
- Isolate faults in I/O interface circuitry
- Use diagnostic software
- Repair faults

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Apply troubleshooting and repair techniques to manufacturing systems**

**Competency Builders:**

- Identify individual process blocks of assembly line or process
- Identify process block interfaces
- Demonstrate steps required for efficient systems troubleshooting
- Isolate system faults to process block
- Isolate block faults using schematics
- Isolate block faults using programmable controller indicators
- Isolate block faults using volt meter
- Repair block faults by replacing fault component or wiring

## **Unit: Electronics Troubleshooting and Repair for IM**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Demonstrate troubleshooting skills**

**Competency Builders:**

- Explain role of preventive maintenance
- Differentiate normal and abnormal operations
- Explain troubleshooting procedures
- Explain logical actions taken to troubleshoot
- Identify and use proper troubleshooting aids and tools
- Demonstrate knowledge of safety rules for troubleshooting and repair procedures
- Maintain troubleshooting and repair records
- Interpret prints
- Use manufacturer's manuals, schematics, and troubleshooting charts
- Isolate faults, shorts, and open circuits

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:** **Apply troubleshooting and repair techniques to manufacturing systems**

**Competency Builders:**

- Identify individual process blocks of assembly line or process
- Identify process block interfaces
- Demonstrate steps required for efficient systems troubleshooting
- Isolate system faults to process block
- Isolate block faults using schematics
- Isolate block faults using programmable controller indicators
- Isolate block faults using volt meter
- Repair block faults by replacing fault component or wiring

# **Unit: Electronic Product Servicing Technology**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in surface mounted devices

**Competency Builders:**

Describe the principles and operation of types of surface mounted devices (SMDs) for DC, AC, and solid-state circuits

Describe the proper procedure for handling static sensitive devices (ESD prevention)

Locate defective SMDs using appropriate troubleshooting techniques

Replace SMDs using appropriate troubleshooting techniques

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in radio and television receiving systems

**Competency Builders:**

- Interpret radio and television receiving system block diagrams
- Describe the principles and operation of a superhetrodyne receiver
- Construct a superhetrodyne receiver
- Align a superhetrodyne receiver
- Troubleshoot a superhetrodyne receiver
- Repair a superhetrodyne receiver
- Describe the principles of video signal generation
- Describe the principles and operation of TV circuits
- Troubleshoot TV circuits
- Repair TV circuits
- Perform operating systems check to radio and television receiving systems
- Adjust radio and television systems
- Describe High Definition Television systems
- Operate video analyzers
- Operate National Television Signal Codes (NTSC) generators
- Operate cathode ray tube (CRT) analyzers
- Operate stereo generators

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in video recording and playback systems

**Competency Builders:**

- Describe characteristics associated with recording and playback systems
- Interpret video recording system block and circuit diagrams
- Identify operational status of video recording systems (mechanical and electronic)
- Perform operating systems check to video recording systems
- Adjust video recording systems
- Describe the operating characteristics and application of BETA, VHS and 8mm test equipment
- Demonstrate the operating characteristics and application of BETA, VHS and 8mm test equipment
- Operate vectorscopes and wave form monitors
- Describe the operating characteristics and application of BETA, VHS and 8mm recorders and playback systems
- Describe the operating characteristics and application of camcorders
- Demonstrate the operating characteristics and application of camcorders
- Troubleshoot video recording systems
- Repair video recording systems
- Describe electronic chemicals (e.g., solvents, lubricants, anticorrosives)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in laser disc systems

**Competency Builders:**

- Describe characteristics associated with laser disc systems
- Interpret laser disc system blocks and circuit diagrams
- Describe the operation of laser disc systems
- Demonstrate the operation of laser disc systems
- Describe the principles and operation of interactive video
- Troubleshoot laser disc systems
- Repair laser disc systems

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in home electronics systems

**Competency Builders:**

Describe characteristics associated with home automation systems (e.g., computers and peripherals)

Interpret home automation systems block and circuit diagrams

Describe the operation of home automation systems

Replace home automation systems

Describe the principles and operation of fax machines

Demonstrate the operation of fax machines

Describe characteristics associated with electronic security systems

Describe the installation of an electronic security systems

Demonstrate the operation of electronic security systems

Troubleshoot home electronics systems

Repair home electronics systems (e.g., replace and align electronic components)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in audio systems

**Competency Builders:**

Describe the principles and operation of audio systems

Interpret audio systems block and circuit diagrams

Demonstrate the operation of audio systems

Describe the principles and operation of digital audio tape (DAT)

Describe the principles and operation of digital compact cassette (DCC)

Troubleshoot audio systems

Repair audio systems (e.g., replace audio components)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in antenna systems  
(CATV/SATV)

**Competency Builders:**

- Describe the principles and operation of antennae systems
- Demonstrate the installation of antenna systems
- Describe the principles and operation of a CATV system
- Demonstrate the operation of a CATV system
- Describe the principles and operation of a SATV system
- Demonstrate the operation of a SATV system
- Troubleshoot antenna systems
- Repair antenna systems (e.g., replace and align antenna components)

## **Unit: Programmable Logic Controllers (PLCs)**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Differentiate among instrumentation and control**

**Competency Builders:**

Describe characteristics associated with automatic controls

Define proportional control

Define integral control

Define derivative control

Describe advantages of using proportional, integral or derivative control

Describe disadvantages of using proportional, integral or derivative control

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:** Explain basic operation of PLCs

**Competency Builders:**

- Describe basic applications of PLCs
- Identify program symbols and language functions
- Describe function of block transfers
- Describe operation of timers, counters, and sequences
- Describe operation of analog I/O modules
- Describe operation of servo motion control
- Describe the principles and operation of PLCs

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**      **Demonstrate use of PLCs**

**Competency Builders:**

- Draw block diagram of a PLC
- Define individual blocks of a PLC
- Use operator's and/or manufacturer's manual(s)
- Translate relay logic to logic for a PLC
- Use function of block transfers
- Operate timers, counters and sequencers
- Operate analog I/O modules
- Operate servo motion control
- Install a PLC
- Connect controller to sensors
- Describe test procedures for new installation of a PLC
- Troubleshoot hardware faults on a PLCs
- Use safety interlock
- Describe use of Graphic Programmable Panel (GPP)
- Write a statement and ladder logic program
- Document a statement and ladder logic program
- Use a PLC program
- Troubleshoot a program for a PLC
- Repair a program for a PLC

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,M

**Competency:** **Apply robot fundamentals**

**Competency Builders:**

- Describe the operation of robotic work cells
- Operate robotic work cells
- Troubleshoot robotic work cells
- Repair robotic work cells
- Classify robots according to industry criteria
- Identify robot power drive types
- Describe positioning in terms of axis, actuators and coordinate system
- Identify types of control systems and sensors
- Apply different methods of programming (e.g., teach, off-line)
- Write simple programs to exercise robot functions
- Join programs to perform full function
- Identify principles of robot safety
- Describe operation of various sensors used in robot control
- Interface sensors to robot
- Interface robots
- Define open loop and closed loop control
- Design a simple automated system to perform manufacturing operation
- Identify operation of end-effectors

# **Unit: Communications Electronics Technology for ET**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,M,S

**Competency:** **Describe transmission line applications**

**Competency Builders:**

Explain power conversion

Describe principles and operation of two wire and four wire transmission lines

Describe principles and operation of coaxial cable

Describe principles and operation of microwave guide

Describe principles and operation of fiber optics

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in transmitters and receivers

**Competency Builders:**

Explain the purpose of Federal Communication Commission (FCC) rules and regulations

Describe principles and operation of RF amplifiers

Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, DSSC, Pulse Modulation)

Construct modulators/demodulators

Operate modulators/demodulators

Describe principles and operation of microwave and satellite communication systems

Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:**      **Describe various types of multiplexing systems**

**Competency Builders:**

Describe principles and operation of analog multiplexing systems (e.g., CATV)

Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Troubleshoot transmitters and receivers

**Competency Builders:**

Isolate system faults in CRT modulation/demodulation circuits

Isolate system faults in RF transmitters and receivers

Isolate system faults in RF modulation/demodulation circuits

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate basic proficiency in data communications

**Competency Builders:**

- Describe principles and operation of data communications, signaling systems, codes, formats and protocols
- Describe principles and operation of parallel and serial ports
- Describe principles and operation of synchronous and asynchronous signals
- Describe principles and operation of data modems
- Operate data modems
- Describe principles and operation of fax machines
- Describe principles and operation of various types of networks (e.g., ethernet, token ring)
- Demonstrate operation of various types of networks
- Describe and demonstrate proper techniques for cable termination (e.g., UTP, COAX, FIBER)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Troubleshoot data communications

**Competency Builders:**

Isolate system faults in data modems

Isolate system faults in various types of networks

Isolate system faults in various types of cable

Isolate system faults in various types of carrier systems

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** **Demonstrate basic proficiency in fiber optic communications systems**

**Competency Builders:**

- Describe and demonstrate proper techniques for fiber splicing
- Demonstrate techniques for fiber termination
- Describe basic characteristics of optics such as reflection, total reflection, and refraction
- Describe characteristics and components of fiber optic cables
- Describe band width and attenuation limitations for fiber optic systems
- Describe technique of wavelength multiplexing in fiber optic cables
- Describe characteristics of various types of light sources and light detectors used in fiber optic systems
- Describe components of fiber optic transmission systems
- Describe transformation of data signals into light pulses
- Operate a simple fiber optic data transmission system
- Describe proper techniques of fiber termination
- Describe characteristics of multi mode and single mode systems

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate proficiency in RF systems safety

**Competency Builders:**

Demonstrate safety procedures for working with RF systems antennae and support structures (e.g., towers)

Demonstrate safety procedures for working with RF systems high voltage/power supply

Demonstrate safety procedures for working with RF generators

Demonstrate safety procedures for working in RF radiating environments

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate basic proficiency in antenna systems

**Competency Builders:**

Describe the principles and operation of single element antennae (e.g., 1/4 wave dipole, longwire, vertical)

Describe the principles and operation of multi-element antennae (e.g., point-to-point, broadcast)

Describe the principles and operation of impedance matching of antennae systems

Describe antennae systems measurement

# **Unit: Communications Electronics Technology for EM**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** **Describe transmission line applications**

**Competency Builders:**

Explain power conversion

Describe principles and operation of two wire and four wire transmission lines

Describe principles and operation of coaxial cable

Describe principles and operation of microwave guide

Describe principles and operation of fiber optics

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Demonstrate proficiency in transmitters and receivers

**Competency Builders:**

Explain the purpose of Federal Communication Commission (FCC) rules and regulations

Describe principles and operation of RF amplifiers

Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, DSSC, pulse modulation)

Construct modulation/demodulation device

Operate modulation/demodulation device

Describe principles and operation of microwave and satellite communication systems

Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)

Describe principles of spread spectrum communications

Describe RS232/RS485 Bus

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** **Describe various types of multiplexing systems**

**Competency Builders:**

Describe principles and operation of analog multiplexing systems (e.g., CATV)

Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)

Describe principles and operation of CRT modulation

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Troubleshoot transmitters and receivers

**Competency Builders:**

Isolate system faults in RF amplifiers

Isolate system faults in CRT modulation/demodulation circuits

Isolate system faults in RF transmitters and receivers

Isolate system faults in RF modulation/demodulation circuits

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** **Demonstrate basic proficiency in data communications**

**Competency Builders:**

Describe principles and operation of data communications, signaling systems, codes, formats and protocols

Describe principles and operation of parallel and serial ports

Describe principles and operation of synchronous and asynchronous signals

Describe principles and operation of data modems

Operate data modems

Describe principles and operation of fax machines

Describe principles and operation of types of carrier systems

Describe principles and operation of various types of networks (e.g., ethernet, token ring)

Demonstrate operation of various types of networks

Describe proper techniques for cable termination (e.g., UTP, COAX, FIBER)

Demonstrate proper techniques for cable termination

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Troubleshoot data communications

**Competency Builders:**

Isolate system faults in data modems

Isolate system faults in various types of networks

Isolate system faults in various types of cable

Isolate system faults in various types of carrier systems

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Demonstrate basic proficiency in fiber optic communications systems

**Competency Builders:**

Describe proper techniques for fiber splicing

Demonstrate proper techniques for fiber splicing

Demonstrate techniques for fiber termination

Describe basic characteristics of optics such as reflection, total reflection, and refraction

Describe characteristics and components of fiber optic cables

Describe band width and attenuation limitations for fiber optic systems

Describe technique of wavelength multiplexing in fiber optic cables

Describe characteristics of various types of light sources and light detectors used in fiber optic systems

Describe components of fiber optic transmission systems

Describe transformation of data signals into light pulses

Operate a simple fiber optic data transmission system

Describe proper techniques of fiber termination

Describe characteristics of multi mode and single mode systems

# **Unit: Industrial Electricity**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	S,M,C

**Competency:** Explain basic industrial electricity theory

## **Competency Builders:**

- Describe atomic structure and its relationship to electricity
- Describe the relationship between electrical and magnetic properties
- Describe the electrical and magnetic properties of a magnet
- Describe the photoelectric effect
- Describe the thermocouple effect
- Describe the electrical effect of friction
- Identify sources of electricity
- Identify potential sources of electricity
- Describe differences between AC/DC
- Describe effects varying degrees of electricity have on the human body

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      Use the National Electrical Code (NEC), International and OSHA Codes

**Competency Builders:**

- Use NEC to identify correct materials
- Use NEC to identify correct methods
- Use NEC to identify correct applications
- Use NEC to identify correct safety procedures
- Identify and use European Economic Commission (EEC) codes
- Use lock-out, tag-out procedures
- Identify hazardous areas

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      Explain operation of electrical distribution systems

**Competency Builders:**

Follow NEC, local, state, and national codes

Describe functions of permits and licensing requirements

Explain generation of electricity

Explain transmission of electricity

Explain end user distribution

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	S

**Competency:**            **Maintain basic electrical systems**

**Competency Builders:**

Replace electrical cords

Replace batteries

Replace fuse(s)

Replace switches and other sensors

Replace plugs and sockets

Replace control panel components (e.g., relays, motor starters)

Replace AC motors (e.g., 3 phase, single phase)

Replace DC motors

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	S

**Competency:**      **Interpret electrical/electronic drawings**

**Competency Builders:**

Interpret basic electric/electronic standards and symbols (e.g., IEC, IEEE)

Interpret schematic drawings

Interpret cable drawings

Interpret component drawings

Interpret logic diagrams

Interpret control panel drawings

Interpret connection drawings

Interpret interconnection drawings

Interpret printed circuit board drawings

Interpret harness drawings

Interpret package drawings

Interpret mechanical/electronic production drawings and assembly drawings

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,M,S

**Competency:**      **Demonstrate proficiency in direct current (DC) circuits**

**Competency Builders:**

Describe voltage, current, resistance, power, and energy

Solve algebraic problems to include exponential (prerequisite to DC)

Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes

Apply Ohm's Law

Construct parallel circuits

Construct series circuits

Construct series parallel and bridge circuits

Define voltage divider circuits (loaded and unloaded)

Construct DC circuits that demonstrate the maximum power transfer theory

Solve problems in electrical units utilizing metric units

Describe the principles and operation of electrochemical supplies

Apply Kirchhoff's laws

Interpret color codes and symbols to identify electrical components and values

Measure properties of a circuit using analog and digital meters and oscilloscopes

Measure conductance and resistance of conductors and insulators

Describe magnetic properties of circuits and devices

Describe the physical and electrical characteristics of capacitors and inductors

Describe RC and RL time constants

Set up power supplies for DC circuits

Operate power supplies for DC circuits

Apply Thevenin's and Norton's theorems

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Demonstrate proficiency in alternating current (AC) circuits**

**Competency Builders:**

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)

Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter, and function generator

Analyze power in AC circuits

Measure power in AC circuits

Operate capacitor and inductor analyzers for AC circuits

Analyze properties of an AC signal

Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms

Identify AC sources

Describe the principles and operation of the characteristics of capacitive circuits

Demonstrate the operation of capacitive circuits

Describe the principles and operation of the characteristics of inductive circuits

Demonstrate the operation of inductive circuits

Describe the principles and operation of the principles of transformers

Demonstrate the operation of AC circuits utilizing transformers

Operate differentiators and integrators to determine RC and RL time constants

Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)

Demonstrate the operation of RLC circuits (series, parallel, and complex)

Describe the principles and operation of the characteristics of series and parallel resonant circuits

Operate series and parallel resonant circuits

Describe the principles and operation of the characteristics of frequency selective filter circuits

Demonstrate the operation of frequency selective filter circuits

Operate polyphase circuits

Describe basic motor theory and operation

Describe basic generator theory and operation  
Operate power supplies for AC circuits  
Describe the principles and operation of various power conditioning (e.g., isolation  
transformers, surge suppressors, uninterruptable power systems)  
Describe the principles and operation of various safety grounding systems (e.g.,  
lightning arresters, ground fault interrupters)  
Apply maximum power transfer theorems  
Apply Thevenin's and Norton's theorems to analyze AC networks  
Identify harmonics problems  
Correct harmonics problems

## **Unit: Wiring Methods**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:** **Apply National Electrical Code (NEC) and National Fire Protection Act (NFPA) regulations**

**Competency Builders:**

- Use NEC and NFPA to identify correct materials
- Use NEC and NFPA to identify correct methods
- Use NEC and NFPA to identify correct applications
- Use NEC and NFPA to identify correct safety procedures

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Explain circuit protectors**

**Competency Builders:**

- Explain grounding/bonding methods
- Explain ground-fault circuit interrupters
- Explain overcurrent/short circuit protection
- Explain thermal protective devices
- Explain difference between ground-fault interrupter and ground-fault protection

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Install wiring**

**Competency Builders:**

Describe functions of permits and licensing requirements

Interpret prints

Verify on-site dimensions

Install electrical boxes and panels

Describe overhead and underground service

Calculate load size conductors

Identify proper color coding

Lay out conduit runs

Install rigid conduit

Install nonmetallic rigid conduit

Install cable trays

Install flexible conduit

Install liquid-tight flexible conduit

Pull conductors

Install ground bonding systems

Install various wire connectors

Inspect rough installation

Prepare for agency inspection

Install bus-duct(s), bus-plug(s), and bus-drop(s)

Install EMT

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Finish wiring**

**Competency Builders:**

Install plugs and switches

Test plugs and switches

Install fixtures

Test fixtures

Install overcurrent protection

Test overcurrent protection

Install ground-fault interrupters (GFI)

Test ground-fault interrupters (GFI)

Install circuit breakers

Test circuit breakers

Label circuit breakers

Update prints and schematics

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Prepare for electrical/ electromechanical equipment installation**

**Competency Builders:**

Identify electrical requirements for equipment

Interpret NEC, NFPA, IEC, and state and local electrical codes

Identify a power distribution source/requirements

Interpret symbols

Interpret schematics/drawings

Prepare site

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Install electrical/electromechanical equipment**

**Competency Builders:**

- Build control panel
- Install electrical motor control systems
- Install electrical motors
- Install sensors and various input devices
- Install energy-management systems (e.g., lighting, HVAC, load-shedding)
- Test equipment and circuits
- Connect power to equipment
- Test power to equipment

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Interpret schematics and diagrams**

**Competency Builders:**

Identify circuit function

Interpret electrical symbols

Interpret block and ladder diagrams

Interpret schematics

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Trace circuits to locate problems**

**Competency Builders:**

Identify circuit type or subsystem

Locate specific circuits

Apply proper troubleshooting technique(s)

Analyze AC signals using VOM, oscilloscope, or tick tracer

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Maintain electrical systems**

**Competency Builders:**

Diagnose failure

Explain root cause of failure

Review schematic or ladder diagram

Repair or replace defective electrical apparatus

Document corrective action needed or taken

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	

**Competency:**      Use soldering tools

**Competency Builders:**

Select appropriate soldering tools and supplies for job

Perform soldering and desoldering techniques (e.g., micro-miniature, standard)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Install Class II systems**

**Competency Builders:**

Define Class II systems

Comply with local, state, and federal codes (e.g., NEC, NFPA)

Install communication system

Install control system

Install lighting system

Install security systems

Install energy management monitoring systems

Maintain systems

Verify system operation

# **Unit: Electrical Test and Measurement Equipment**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Demonstrate proficient use of electrical test equipment**

**Competency Builders:**

- Describe function and operation of logic probe and logic analyzer
- Describe function and operation of power monitor
- Describe function and operation of signal generator
- Describe function and operation of spectrum analyzer
- Describe function and operation of AC/DC hi-pot
- Describe function and operation of time-domain reflectometer (TDR)
- Describe function and operation of megger
- Describe function and operation of curve tracer/analogger
- Apply test equipment to DC circuits
- Apply test equipment to AC circuits
- Apply test equipment to solid-state devices
- Apply test equipment to digital circuits
- Apply test equipment to analog circuits
- Apply test equipment to microprocessors

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,S,M

**Competency:**      **Demonstrate proficient use of electrical measurement equipment**

**Competency Builders:**

Describe function and operation of analog volt-ohm-meter (AVOM)

Describe function and operation of digital volt-ohm-meter (DVOM)

Describe function and operation of clamp-on amp meter

Describe function and operation of oscilloscopes

Apply measurement equipment to DC circuits

Apply measurement equipment to AC circuits

Apply measurement equipment to solid-state devices

Apply measurement equipment to digital circuits

Apply measurement equipment to analog circuits

Apply measurement equipment to microprocessors

## **Unit: Electronic Assembly and Repair**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	

**Competency:**      **Perform basic soldering of electrical components**

### **Competency Builders:**

- Prepare surfaces to be soldered
- Select appropriate solder
- Select appropriate flux
- Select appropriate soldering iron temperature
- Select appropriate soldering iron tip shape
- Select appropriate flux remover
- Select appropriate surface sealant
- Inspect solder joints under microscope
- Identify good and bad solder joints – SMT and PTH
- Measure solder joint resistance of good and bad joints
- Demonstrate solder techniques for SMD components
- Demonstrate techniques for soldering to terminals

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Perform basic repair of electronic boards

**Competency Builders:**

Demonstrate removal of SMD

Demonstrate removal of PTH components

Demonstrate PCB track repair

Demonstrate use of solder removal tools

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Operate wave soldering machine

**Competency Builders:**

Inspect surfaces to be soldered

Select appropriate solder

Select appropriate flux

Set all machine parameters (e.g., temperature, wave amplitude, transport velocity)

Inspect solder joints of completed printed circuit boards

## **Unit: Equipment Installation**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Explain installation procedures**

**Competency Builders:**

- Explain relocation procedures for new equipment in an existing facility
- Explain the use of anchors and isolators
- Explain procedures for moving and installing new equipment
- Explain leveling and aligning procedures
- Explain test run guidelines
- Explain safety precautions for equipment installation procedures
- Explain grounding procedures
- Explain installation of utilities (e.g., electricity, air, water, drains)

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:**            **Prepare for equipment installation**

**Competency Builders:**

- Identify equipment requirements (including safety)
- Identify maintenance services needed
- Identify method of moving and equipment needed
- Identify measuring devices
- Calculate weights
- Follow manufacturer's specifications and manuals
- Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
- Read drawings/schematics
- Revise drawings if applicable
- Interpret prints

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:**      **Install Equipment**

**Competency Builders:**

Prepare site

Use measuring devices

Calculate weight

Follow manufacturer's specifications

Use appropriate moving equipment

Align equipment to layout specifications

Apply electrical, mechanical, hydraulic, and/or pneumatic principles

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:**            **Explain rigging functions**

**Competency Builders:**

Estimate the weight of a load

Find the center of gravity

Identify the rigging and slings used in maintenance work

Explain safety inspection procedures for rigging, ropes, and slings

Perform safety inspection procedures for rigging, ropes, and slings

Identify rope fiber types

Tie rigging knots, bends, and hitches

Identify types of wire rope

Cut wire rope assemblies and termination's

Identify cranes and hoists

Identify and explain scaffolding types

Identify safety equipment (e.g., safety harness, nets)

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**            **Perform rigging functions**

**Competency Builders:**

Perform safety inspection procedures for rigging, ropes, and slings

Tie rigging knots, bends, and hitches

Cut wire rope

Seize wire rope

Splice wire rope

Erect a scaffold per new OSHA standards

Rig safety harness and nets

## **Unit: Equipment Maintenance**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:** **Perform housekeeping**

**Competency Builders:**

Dispose of scrap metal chips, shavings, trash and waste

Clean work area

Store hand tools, cutters, fixtures, jigs, and attachments

Store grinding wheels

Follow tool crib procedures

Inspect machine guards

Replace or adjust machine guards

Report problems to supervisor

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C

**Competency:**            **Perform recordkeeping**

**Competency Builders:**

Explain reasons for keeping maintenance records

Explain reasons for keeping cost records

Complete work order

Complete internal requisition

Complete external requisition

Complete time cards

Complete job status reports

Complete equipment failure reports

Record preventive maintenance activities

Record repair activities

Read job orders and process sheets

Locate tooling and set up information

File reports

Prepare new/replacement equipment recommendations

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**            **Inspect machine systems**

**Competency Builders:**

- Explain planned maintenance
- Explain predictive maintenance measures
- Explain preventive maintenance measures (e.g., lubrication)
- Log machine histories
- Explain machine system(s) calibration
- Inspect linkages and lever mechanisms
- Inspect drive couplings
- Inspect clutches
- Inspect roller ball bearings
- Inspect safety systems
- Analyze system failure
- Make minor adjustments/repairs
- Coordinate maintenance services

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C

**Competency:**      **Perform machine maintenance**

**Competency Builders:**

Use operator's and manufacturer's manuals

Operate individual machines

Diagnose malfunctions

Apply lockout/tagout procedure

Disassemble defective section

Clean equipment

Lubricate equipment

Check equipment for wear and alignment

Repair or replace defective parts

Test machine for performance

Make minor adjustments to equipment

Prepare planned maintenance schedules

Explain breakdown maintenance

Review analysis with operator

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**      **Maintain and properly use hand tools**

**Competency Builders:**

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)

Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing

Demonstrate use and care of common hand tools

Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)

Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)

Demonstrate use and care of ropes, slings, pullers, and block and tackle

Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)

Demonstrate use and care of pipe clearing equipment

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Maintain and properly use portable power tools**

**Competency Builders:**

- Demonstrate use and care of light-duty and heavy-duty drills
- Demonstrate use and care of electric hammers
- Demonstrate use and care of pneumatic drills and hammers
- Demonstrate use and care of power screwdrivers and impact wrenches
- Demonstrate use and care of linear motion saws
- Demonstrate use and care of circular saws
- Demonstrate use and care of routers and planes
- Demonstrate use and care of belt, pad, and disc sanders
- Demonstrate use and care of grinders and shears
- Demonstrate use and care of explosive actuated tools
- Demonstrate use and care of electric lifts

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Maintain and properly use stationary equipment**

**Competency Builders:**

- Demonstrate use and care of mechanical presses
- Demonstrate use and care of hydraulic presses
- Demonstrate use and care of drill presses
- Demonstrate use and care of bench grinders
- Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
- Demonstrate use and care of band saws
- Demonstrate use and care of pipe threaders
- Demonstrate use and care of metal brakes
- Demonstrate use and care of power shears

## **Unit: Industrial Engineering Basics**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Apply knowledge of workstation design**

**Competency Builders:**

Participate in development of overall plant layout

Identify minimal movement of materials and parts throughout production line

Plan operator's access to materials and tools

Eliminate unnecessary body moves (e.g., bends, turns, stoops, hand movements)

Identify physical safety items (e.g., equipment, temperature, fumes, light)

Identify methods to prevent operator from reaching across moving parts

List type of material handling equipment for operation

Calculate bench space needs for process and storage

Calculate machine controls to position operator efficiently

Physically simulate operation

Review total process for simplification

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M,C

**Competency:**      **Demonstrate knowledge of ergonomics**

**Competency Builders:**

Define ergonomics

Identify risk factors

Define maximum permissible limit (MPL) and action limit (AL) for lifting

Define cumulative trauma disorder (CTD)

Identify susceptibility factors for CTD

Identify need for mats and footrest for standing jobs

Identify need for appropriate working heights of chairs, stools, workbenches, equipment

Identify need for adequate lighting

Explain use of anthropometric design

Explain use of rest pauses

Minimize extreme joint movement

Minimize use of excessive muscle force

Minimize repetitive tasks

Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)

Minimize awkward body positions

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**            **Apply knowledge of methods engineering**

**Competency Builders:**

Define methods engineering

Define goals of methods engineering (e.g., quality, increase productivity, decrease per unit cost)

Set sequence of production operations

Set sequence of needed inspections

Recommend methods to shorten process time

Recommend alternate operations

Recommend ways to eliminate operations

Ascertain if operations can be performed within facilities

Test machine capability

Follow documentation procedures

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Apply knowledge of standards engineering**

**Competency Builders:**

Estimate times by computer simulation

Use predetermined time system (e.g., MTM family)

Use work sampling

Define reach, grasp, move position, turn, apply pressure, and release

Define standard time

Define performance rating

Define allowances

Identify leveling factors (e.g., skill levels, effort, work area conditions, consistency)

Identify allowance factors (e.g., fatigue, delay, personal)

Calculate production rate

Write job description data

Complete job status reports

Analyze job evaluation data

## **Unit: Industrial Manufacturing Technology**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards of the National Coalition for Advanced Manufacturing and the Metalworking Industry Skills Standards Board. Sources: *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 36-39 and *Duties and Standards for Machining Skills. Level I. Duty 3.* November 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Describe industrial manufacturing processes**

**Competency Builders:**

Identify safety related items

Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature

Explain mechanical and chemical properties of ferrous and non-ferrous metals

Explain industrial manufacturing process

Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases

Develop flow chart and process sheets

Explain preventive maintenance and calibration procedures

Explain need for manufacturing documentation (e.g., ISO 9000)

Define quality process

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Demonstrate knowledge of materials requirements planning (MRP)**

**Competency Builders:**

Define materials requirements planning

Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)

Interpret master production schedule and bill of materials

Explain inventory carrying cost and economic order quantity

Describe the use of the computer in MRP

Calculate net requirements

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Demonstrate knowledge of material supply process (MSP)**

**Competency Builders:**

Describe role of purchase requisitions and/or purchase orders

Describe role of material specifications

Describe role of quality parameters

Define supplier certification rating methods

Describe role of source inspector

Describe role of receiving

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M

**Competency:**      **Demonstrate knowledge of plant layouts**

**Competency Builders:**

Describe the importance of flexibility

Differentiate among product layout, process layout, fixed position layout, and cellular layout

Describe the type of production suited to each layout

Describe advantages and disadvantages of each layout

Describe importance of flexibility of material flow

Differentiate straight-line, U-shaped, convoluted, and comb patterns

Describe advantages and disadvantages of each pattern

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** **Demonstrate knowledge of quality control process of materials handling**

**Competency Builders:**

Maintain system for physical handling and movement of material in-process and in-storage

Monitor system of physical handling and movement of material in-process and in-storage

Maintain system for physical handling and movement of finished products

Monitor system of physical handling and movement of finished products

Write requests for deviation from specifications

Implement quality control and inspection standards and procedures

Write engineering change notices and rejection reports

Monitor reports of discrepancy or rejects during production process

Conduct quality tests under different environmental conditions

Explain importance of product protection, identification and storage

Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)

Describe manual methods of storage and retrieval

Describe automated storage and retrieval systems (ASRS)

Describe automated guided vehicle moving systems (AGVS)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**      **Apply statistical process control techniques**

**Competency Builders:**

Describe (SPC) statistical process control and its applications

Describe a sampling plan

Inspect parts for necessary data

Plot on appropriate control charts

Analyze a manufacturing process

Explain the "how" of project selection

Explain the "how" of project implementation

Explain the "how" of project evaluation

Explain the "how" of planning continuing improvement

Explain the "how" of planning predictive maintenance

# **Unit: Basic Materials Science**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M,C

**Competency:**      **Demonstrate basic knowledge of metallurgy**

## **Competency Builders:**

Define metallurgy

Define metal forming (e.g., general process)

Identify forming industries (e.g., stamping, forging, fabricating)

Describe metal forming principles

Describe the metal forming process

Identify frequently used metals

Describe the crystalline structures of metals

Use periodic chart to evaluate metals

List chemical properties of common metals

List physical properties of common metals

Describe measures of metal strength

Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy

Explain secondary finishing operations (e.g., paint, anodizing)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      Demonstrate basic knowledge of heat treatment

**Competency Builders:**

Describe process of heat treating

Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic knowledge of metal characteristics and formability**

**Competency Builders:**

- Explain metal and formability basics
- Explain metal grades and coatings
- Explain part contour analysis
- Explain tensile test
- Explain LDH test
- Explain bend test
- Explain hold expansion test
- Explain R-value test
- Explain hardness test
- Explain cup test
- Explain friction test
- Explain surface test
- Explain interpretation of metal characteristics tests
- Describe blank/die interactions (e.g., friction)
- Describe friction and forming process
- Describe circle grid basics
- Describe circle grid applications
- Describe formability diagnostics
- Describe the documentation process

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**            Demonstrate basic knowledge of casting

**Competency Builders:**

- Identify frequently used metals
- Describe crystalline structures of metals
- Use periodic chart in evaluating metals
- List chemical properties of common metals
- List physical properties of common metals
- Define permanent mold casting
- Define shell mold casting
- Define sand casting and pattern making
- Define die casting
- Identify basic casting terms
- Identify advantages/disadvantages of casting processes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic knowledge of iron and its alloys**

**Competency Builders:**

Define iron and its alloys

Describe iron manufacturing process

Describe the structure of iron and its alloys

List chemical properties of iron and its alloys

List physical properties of iron and its alloys

Describe iron and alloys property variables

Describe measures of strength for iron and its alloys

Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining

Perform tensile test

Perform Brinell test

Perform chemical analysis

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic knowledge of aluminum and its alloys**

**Competency Builders:**

Define aluminum and its alloys

Describe aluminum manufacturing process

Describe the structure of aluminum

List chemical properties of aluminum

List physical properties of aluminum

Describe aluminum property variables

Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining

Perform tensile test

Perform Brinell test

Perform chemical analysis

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      Demonstrate basic knowledge of copper and its alloys  
(e.g., brass, bronze)

**Competency Builders:**

- Define copper and its alloys
- Describe copper manufacturing process
- Describe the structure of copper
- List chemical properties of copper
- List physical properties of copper
- Describe copper property variables
- Describe measures of copper strength
- Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
- Perform tensile test
- Perform Brinell test
- Perform chemical analysis

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic knowledge of plastics and polymers**

**Competency Builders:**

Define thermo-analysis testing (e.g., melt flow, moisture control)

Define plastics and polymers

Describe plastics and polymers manufacturing processes

Describe structure of plastics and polymers

List chemical properties of plastics and polymers

List physical properties of plastics and polymers

Differentiate thermoset and thermoplastic

Describe plastics and polymer property variables

Describe measure of plastic and polymer strength

Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding

Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)

Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)

Perform tensile test

Perform R-value test

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic knowledge of ceramics**

**Competency Builders:**

List Ingredients of ceramic products

List qualities of ceramic products

Describe quality control tests (e.g., compressive strength test, wear resistance test, temperature resistance test)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic knowledge of concrete**

**Competency Builders:**

Describe the formation of concrete

List types of cements and their uses

Define qualities of concrete (e.g., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)

List tests used in concrete production (e.g., slump test, test of fineness modules)

List protective practices used after pouring

Describe concrete tools and applications (e.g., float, chairs)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate knowledge of corrosion and protection**

**Competency Builders:**

Identify causes of corrosion

Identify types of corrosion

List solutions to minimize problems

Identify corrosion testing

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate basic knowledge of rubber manufacturing**

**Competency Builders:**

Explain history of rubber industry

Compare properties of natural rubber with those of synthetic rubber

Explain how natural rubber is manufactured

Explain vulcanization, mastication, and cure systems

Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)

Explain press and autoclave curing

Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)

Explain rubber testing (e.g., tensile, durometer)

# **Unit: Mechanical Power Transmission**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Demonstrate knowledge of basic mechanics**

**Competency Builders:**

Explain working forces of torque, tension, and compression

Explain the laws of motion

Explain how to calculate work in several ways

Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw, gears

Explain the types of power and the method of producing power

Explain the laws of friction

Explain mechanical efficiency

Apply basic knowledge of physics

Apply basic knowledge of stress, strain, and fatigue

Calculate speed changes

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**            **Describe mechanical power transmission systems**

**Competency Builders:**

- Describe the principles and operation of compound and reverted gear trains
- Describe the principles and operation of internal and planetary gear trains
- Describe the principles and operation of helical and bevel gear trains
- Describe the principles and operation of rack and pinion, worm and wheel, and block and screw mechanisms
- Describe the principles and operation of counter rotating mechanisms and differentials
- Describe the principles and operation of spring mechanisms, pulley blocks, and differentials
- Describe the principles and operation of chain, belt and disc drives and universal joints
- Describe the principles and operation of clutch and coupling mechanisms
- Describe the principles and operation of braking mechanisms
- Describe the necessity for proper alignment and fit of mechanical devices
- Describe the necessity for proper balance of system components
- Describe proper component matching (e.g., sheave sets, gear sets)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      Use bearings

**Competency Builders:**

Define bearing

Identify types of bearings and their applications

Identify installation method

Install bearings

Maintain bearings (e.g., lubrication)

Remove bearings

Identify bearing failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Use seals**

**Competency Builders:**

Define seal

Identify types of seals and their applications

Identify installation method

Install seals

Maintain seals

Remove seals

Identify failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      **Use gears**

**Competency Builders:**

Define gears

Identify types of gears, their materials, and their applications

Identify installation method

Install gears

Maintain gears (e.g., lubrication)

Remove gears

Identify failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      Use sheaves

**Competency Builders:**

Define sheaves

Identify types, tolerances, and materials of sheaves and their applications

Identify installation method

Install sheaves

Maintain sheaves

Remove sheaves

Identify failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Use belts and pulleys**

**Competency Builders:**

Define belts and pulleys

Identify types of belts and pulleys and their applications

Identify installation method

Install belts and pulleys

Maintain belts and pulleys

Remove belts and pulleys

Identify failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Use sprockets and chains**

**Competency Builders:**

Define sprockets and chains

Identify types of sprockets and chains and their applications

Identify installation method

Install sprockets and chains

Maintain sprockets and chains

Remove sprockets and chains

Identify failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Use cams and levers**

**Competency Builders:**

Define cams and levers

Identify types of cams and levers and their applications

Identify installation method

Install cams and levers

Maintain cams and levers

Remove cams and levers

Identify failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      Use clutches and brakes

**Competency Builders:**

Define clutches and brakes

Identify types of clutches and brakes and their applications

Identify installation

Install clutches and brakes

Maintain clutches and brakes

Remove clutches and brakes

Identify failure modes

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Install drive components**

**Competency Builders:**

- Identify types of couplings and their applications
- Install solid coupling
- Install jaw coupling
- Install molded rubber coupling
- Install chain type coupling
- Install a clutch
- Install brakes
- Align bearings, bushing, and cams
- Install V-belts and adjust tensions
- Install a V-belt and manually adjustable sheaves
- Adjust a V-belt and manually adjustable sheaves
- Install a V-belt with spring loaded adjustable sheaves
- Explain the purposes and advantages of a chain drive system
- Explain the function of speed reducers
- Explain the function of gears and variable speed reducers
- Install shafts
- Align shafts
- Mount drive sprockets and chains
- Mount sheaves and pulleys
- Mount gears on open gear drives
- Align gears on open gear drives
- Install a mechanical clutch system
- Install adjustable speed drives
- Troubleshoot adjustable speed drives
- Explain the operation of fluid couplings
- Install fluid couplings
- Install torque converters
- Perform preventive maintenance on drive components
- Inspect completed work

Describe types of fit and tolerances  
Explain importance of balance

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Describe the operation of mechanisms, linkages and levers**

**Competency Builders:**

Describe class one, two, three, and compound levers

Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms

Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)

Describe the principles and operation of drag link and intermediate mechanisms

Describe the principles and operation of four-bar variations

Describe the principles and operation of cam mechanisms

Describe the principles and operation of pivoted follower mechanisms

Describe the principles and operation of toggle, quick return, and ratchet mechanisms

Describe the principles and operation of geneva mechanisms

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**            **Apply knowledge of lubricants**

**Competency Builders:**

Explain the function of lubricants

Explain the properties of oil lubricants and factors determining the selection of lubricants

Identify types and functions of lubricant additives

Describe types of circulating oils and their purposes

Describe lubricating systems, including the charts and methods used

Demonstrate proper grease application

Demonstrate proper lubricant storage and handling

Lubricate a piece of industrial equipment

Identify specified lubricant or equivalent

Explain lubricant recovery and disposal

Explain use of oil analysis reports

## **Unit: Fundamentals of Machine Anatomy**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,C,M

**Competency:**      Interpret specifications for a machine

### **Competency Builders:**

- Identify power source
- Identify power transmission
- Identify hydraulic/pneumatic actuators
- Identify materials
- Identify fits/tolerances
- Identify geometric dimension and tolerancing (GD&T) symbols
- Identify safety factors
- Participate in concurrent engineering
- Demonstrate knowledge of print reading

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      **Build a machine to specifications**

**Competency Builders:**

- Install hydraulic and pneumatic actuators
- Troubleshoot hydraulic and pneumatic actuators
- Install motors
- Troubleshoot motors
- Install sensors
- Troubleshoot sensors
- Install PLC's
- Troubleshoot PLC's
- Install industrial controls
- Troubleshoot industrial controls
- Install power distribution systems
- Troubleshoot power distribution systems
- Install brakes and clutches
- Troubleshoot brakes and clutches
- Install lubrication system
- Troubleshoot lubrication system

# **Unit: Electromechanical Technology**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:** Interpret electromechanical drawings

**Competency Builders:**

Identify types of drawings and their applications

Explain the use of auxiliary views, revolutions, and sectional views

Describe dimensioning practices and techniques on drawings

Interpret mechanical/electronic production and assembly drawings

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Describe the operation of electronic sensors and transducers**

**Competency Builders:**

- Explain temperature transducers operation
- Explain stress and strain transducers operation
- Explain magnetic transducers operation
- Explain liquid and fluid flow transducers operation
- Explain fiber optic system operation
- Explain pressure transducers operation

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**      **Demonstrate knowledge of transducers (sensors) and instrumentation**

**Competency Builders:**

Describe characteristics associated with transducers and instrumentation

Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Troubleshoot transducers

Differentiate among thermocouple types

Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)

Interpret specification of pressure sensors (e.g., strain gage, piezoelectric/piezoresistive) to electrical circuits

Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)

Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT))

Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)

Interpret specifications of final control elements (e.g., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)

Describe application circuits

Calculate specification of proximity sensors

Calculate specifications of infrared and photo-sensors

Explain use of proximity sensors

Explain use of photo electric sensors

Explain use of mechanically activated switches

Troubleshoot switch failure

Describe transducer control and measurement circuits  
Demonstrate the use of control and measurement circuits  
Troubleshoot control and measurement circuits

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,M,S

**Competency:**      **Demonstrate knowledge of power distribution systems**

**Competency Builders:**

- Describe power distribution systems
- Describe poly-phase distribution systems
- Describe single-phase distribution systems
- Describe DC distribution systems
- Describe delta distribution systems
- Describe wye distribution systems
- Describe medium-voltage distribution systems (less than 600v)
- Troubleshoot poly-phase distribution systems
- Troubleshoot single-phase distribution systems
- Troubleshoot DC distribution systems
- Demonstrate lock-out/tag-out procedures
- Describe inner lock systems
- Troubleshoot delta distribution systems
- Troubleshoot wye distribution systems
- Troubleshoot medium-voltage distribution systems

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Demonstrate proficiency in power distribution equipment**

**Competency Builders:**

- Describe power transformers
- Interpret transformer name plate data
- Describe power capacitors
- Describe power oil switches and cutouts
- Describe application of NEMA or IEC controls
- Describe different types of enclosures for controls
- Describe current transformers
- Describe current transformer safety procedures
- Describe potential transformers
- Describe medium-voltage circuits breakers and fuses
- Use medium-voltage safety equipment
- Troubleshoot power transformers
- Demonstrate lock-out/tag-out procedures
- Describe inner lock systems
- Troubleshoot power capacitors
- Troubleshoot power oil switches and cutouts
- Troubleshoot current transformers
- Troubleshoot voltage transformers
- Troubleshoot medium-voltage circuit breakers and fuses

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Demonstrate knowledge of motors and motor control**

**Competency Builders:**

- Test solid state components with ohmmeter
- Test solid state DC motor control circuits
- Test solid state AC motor control circuits
- Calibrate or recalibrate equipment
- Identify SCR and TRIAC AC control circuits
- Explain how load is connected to 3-phase wye configured AC generator
- Identify wye connected and delta connected 3-phase motors
- Explain revolving fields in AC motors
- Describe common start/stop circuits
- Describe operation of common AC motors
- Explain motor starters/overloads
- Explain motor's EFF
- Explain power factor affect on motors
- Describe operation of variable frequency AC drives
- Define advantages and disadvantages of common DC motors
- Explain how motor load affects speed regulation
- Describe operation of stepper motors
- Describe speed control of various types of motor drives using sensors
- Identify defective motors
- Describe regenerative dynamic breaking
- Describe operation of various feedback loops
- Interpret motor name plate data

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**            **Apply quality control techniques**

**Competency Builders:**

Perform preventive maintenance

Perform predictive maintenance

Apply statistical process control (SPC)

Recalibrate equipment

Apply problem-solving tools and techniques

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Apply electromechanical maintenance management practices**

**Competency Builders:**

- Keep maintenance records
- Complete work order
- Complete internal requisition
- Complete external requisition
- Explain planned maintenance
- Explain breakdown maintenance
- Explain predictive maintenance
- Establish maintenance schedules
- Explain reasons for keeping maintenance records
- Explain reasons for keeping cost records
- Explain computer management maintenance systems (CMMS)
- Analyze system failure
- Make minor adjustments/repairs
- Coordinate maintenance service
- Make new/replacement equipment recommendations
- Interpret bill of materials for allocation, stocking, and raw material information
- Analyze use of bill of materials for workplace decision making

## **Unit: Electromechanical Technology for IM**

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C

**Competency:**      **Interpret electromechanical drawings**

**Competency Builders:**

Identify types of drawings and their applications

Explain the use of auxiliary views, revolutions, and sectional views

Describe dimensioning practices and techniques on drawings

Interpret mechanical/electronic production and assembly drawings

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Describe the operation of electronic sensors and transducers**

**Competency Builders:**

Explain temperature transducers operation

Explain stress and strain pressure transducers operation

Explain magnetic transducers operation

Explain liquid and fluid flow transducers operation

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,M,S

**Competency:** Demonstrate proficiency in transducers (sensors) and instrumentation

**Competency Builders:**

Describe characteristics associated with transducers and instrumentation

Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Troubleshoot transducers

Differentiate among thermocouple types

Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)

Interpret specification of pressure sensors (e.g., strain gage, piezoelectric/piezoresistive) to electrical circuits

Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)

Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT))

Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)

Interpret specifications of final control elements (e.g., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)

Describe application circuits

Calculate specification of proximity sensors

Calculate specifications of infrared and photo-sensors

Explain use of proximity sensors

Explain use of photo electric sensors

Explain use of mechanically activated switches

Troubleshoot switch failure

Describe transducer control and measurement circuits  
Demonstrate the use of control and measurement circuits  
Troubleshoot control and measurement circuits

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,S,C

**Competency:** Demonstrate proficiency in power distribution systems

**Competency Builders:**

- Describe power distribution systems
- Describe poly-phase distribution systems
- Describe single-phase distribution systems
- Describe DC distribution systems
- Describe delta distribution systems
- Describe wye distribution systems
- Describe medium-voltage distribution systems (less than 600v)
- Troubleshoot poly-phase distribution systems
- Troubleshoot single-phase distribution systems
- Troubleshoot DC distribution systems
- Demonstrate lock-out/tag-out procedures
- Describe kirk key inner lock systems
- Troubleshoot delta distribution systems
- Troubleshoot wye distribution systems
- Troubleshoot medium-voltage distribution systems

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C,S

**Competency:** Demonstrate proficiency in power distribution equipment

**Competency Builders:**

- Describe power transformers
- Describe transformer name plate data
- Describe power capacitors
- Describe power oil switches and cutouts
- Describe application of NEMA or IEC controls
- Describe different types of enclosures for controls
- Describe current transformers
- Describe current transformer safety procedures
- Describe potential transformers
- Describe medium-voltage circuits breakers and fuses
- Use medium-voltage safety equipment
- Troubleshoot power transformers
- Demonstrate lock-out/tag-out procedures
- Describe kirk key inner lock systems
- Troubleshoot power capacitors
- Troubleshoot power oil switches and cutouts
- Troubleshoot current transformers
- Troubleshoot potential transformers
- Troubleshoot medium-voltage circuit breakers and fuses

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,S,C

**Competency:** Demonstrate proficiency in motors and motor control

**Competency Builders:**

- Test solid state components with ohmmeter
- Test solid state DC motor control circuits
- Test solid state AC motor control circuits
- Calibrate or recalibrate equipment
- Identify SCR and TRIAC AC control circuits
- Explain how load is connected to 3-phase wye configured AC generator
- Identify wye connected and delta connected 3-phase motors
- Explain revolving fields in AC motors
- Describe operation of common AC motors
- Explain power factor effect on motors
- Demonstrate two and three wire control concepts
- Explain motor starter/overloads
- Describe operation of variable frequency AC drives
- Define advantages and disadvantages of common DC motors
- Explain how motor load affects speed regulation
- Describe operation of stepper motors
- Describe speed control of various types of motor drives using sensors
- Identify defective motors
- Describe regenerative dynamic breaking
- Describe operation of various feedback loops
- Explain motor name plate data

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,S,C

**Competency:** Apply quality control techniques

**Competency Builders:**

- Perform preventive maintenance
- Perform predictive maintenance
- Apply statistical process control (SPC)
- Recalibrate equipment
- Apply problem-solving tools and techniques

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,S,C

**Competency:** **Apply electromechanical maintenance management practices**

**Competency Builders:**

- Keep maintenance records
- Complete work order
- Complete internal requisition
- Complete external requisition
- Explain planned maintenance
- Explain breakdown maintenance
- Explain predictive maintenance
- Establish maintenance schedules
- Explain reasons for keeping maintenance records
- Explain reasons for keeping cost records
- Explain computer management maintenance systems (CMMS)
- Analyze system failure
- Make minor adjustments/repairs
- Coordinate maintenance service
- Make new/replacement equipment recommendations
- Interpret bill of materials for allocation, stocking, and raw material information
- Analyze use of bill of materials for workplace decision making

## **Unit: Hydraulics and Pneumatics**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M,C

**Competency:** **Describe fluid flow concepts**

**Competency Builders:**

Explain Pascal's Law

Explain Boyle's Law

Explain Bernoulli's Principle

Describe flow velocity

Explain how heat and pressure relate to power and transmission

Describe physical and chemical properties of a fluid

Describe fluids in motion in closed conductors

Describe continuity of mass flow

Identify types of fluids

Identify properties of fluids

Identify English and metric units of measurement for pressure, density, and viscosity

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	P	R	S,C

**Competency:**            **Describe energy considerations**

**Competency Builders:**

Differentiate work and power

Differentiate potential and kinetic energy

Explain energy conservation concept

Explain hydraulic horsepower

Explain work of compression in compressible fluids

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,C

**Competency:** Describe system losses

**Competency Builders:**

Differentiate turbulent and laminar flow

Explain friction factor

Explain pressure losses

Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	S,C

**Competency:**      **Describe hydrostatics**

**Competency Builders:**

Explain pressure, density, and viscosity

Explain buoyancy

Explain equilibrium

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M

**Competency:**      **Calculate energy**

**Competency Builders:**

- Apply Pascal's Law
- Apply Bernoulli's Principle
- Apply Boyle's Law
- Calculate work and power
- Calculate potential and kinetic energy
- Calculate hydraulic horsepower
- Calculate flow velocity and pressure
- Calculate pressure losses
- Calculate laminar flow
- Calculate pump capacity
- Calculate system requirements

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      Design basic hydraulic/pneumatic system

**Competency Builders:**

Use common symbols

Create circuit diagrams (e.g., schematics)

Diagram closed-loop hydraulic system

Diagram an air supply system

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,C

**Competency:**      **Describe component operation**

**Competency Builders:**

Identify functions and operation of hydraulic components

Identify functions and operation of pneumatic components

Explain application(s) of different materials (e.g., plastic, copper)

Identify and interpret pressure ratings

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      Interpret hydraulic and pneumatic schematics

**Competency Builders:**

Identify common symbols

Sketch circuit diagrams (e.g., schematics)

Interpret circuit diagrams (e.g., schematics)

Analyze circuit

Diagram an air supply system

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S

**Competency:**      **Troubleshoot hydraulic and pneumatic circuits**

**Competency Builders:**

- Analyze hydraulic circuits
- Troubleshoot hydraulic circuits
- Analyze pneumatic circuits
- Troubleshoot pneumatic circuits

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	S,C

**Competency:** **Perform pump maintenance and repair**

**Competency Builders:**

Identify types and operating features of pumps

Identify pump capacity and system requirements

Explain packing and seal requirements

Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)

Perform pump maintenance

Disassemble a pump

Reassemble a pump

Test pump

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	S,C

**Competency:** **Maintain piping and accessories for high and low pressure fluid power systems**

**Competency Builders:**

Identify components of a piping system

Explain maintenance features of both metallic and non-metallic piping systems

Explain types of valves and their operation and maintenance

Explain use and maintenance of strainers, filters, and traps in piping systems

Join common fittings

Join metallic pipe

Join plastic pipe

Join copper and steel tubing

Bend copper and steel tubing

Cut copper and steel tubing

Flare tubing

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,C,S

**Competency:**      **Maintain hydraulic system components**

**Competency Builders:**

- Install a contaminant removal system
- Maintain a contaminant removal system
- Explain operation and use of heat exchanges
- Identify reservoir requirements
- Compute hose requirements
- Install hydraulic lines
- Select control valves and servo-type valves
- Install control valves and servo-type valves

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S

**Competency:**      **Troubleshoot hydraulic systems**

**Competency Builders:**

- Interpret hydraulic schematic
- Identify causes of failure modes
- Connect electrically controlled valves
- Explain hydraulic system troubleshooting techniques
- Repair or replace hydraulic valves
- Repair or replace hydraulic cylinders
- Repair or replace hydraulic pumps and motors
- Install hydraulic components

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,C

**Competency:**      **Describe reciprocating and rotary air compressors**

**Competency Builders:**

Explain relationship of force, weight, mass, and density in pneumatic system

Explain operation of reciprocating compressors

Explain operation of rotary compressors

Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)

Explain operation of compressor valves, cylinders, and motors

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	C,S

**Competency:** Maintain pneumatic systems

**Competency Builders:**

Install pneumatic system components

Explain pneumatic system maintenance techniques

Explain pneumatic system troubleshooting procedures

Isolate faults in air compressors

Repair or replace air compressors

Isolate faults in control valves

Repair or replace control valves

Isolate faults in air motors

Repair or replace air motors

Isolate faults in air dryers

Repair or replace air dryers

Maintain proportioning and servo valves

Safety precautions

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S

**Competency:**      **Troubleshoot pneumatic systems**

**Competency Builders:**

- Interpret pneumatic schematic
- Diagram an air supply system
- Install pneumatic system components
- Explain pneumatic system troubleshooting procedures
- Troubleshoot air compressors
- Troubleshoot pneumatic control valves
- Troubleshoot air motors
- Troubleshoot air dryers

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	C,S

**Competency:** Maintain vacuum systems

**Competency Builders:**

Describe characteristics associated with vacuum systems and sub-atmospheric pressure

Describe the principles and operation of vacuum gauges

Demonstrate use of vacuum gauges

Repair or replace vacuum gauges

Describe the principles and operation of vacuum pumps

Demonstrate use of vacuum pumps

Repair or replace vacuum pumps

Describe the principles and operation of vacuum controls

Demonstrate use of vacuum controls

Repair or replace vacuum controls

## **Unit: Hydraulics and Pneumatics for ET**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M

**Competency:** **Describe fluid flow concepts**

**Competency Builders:**

Explain Pascal's Law

Explain Boyle's Law

Explain Bernoulli's Principle

Describe flow velocity

Explain how heat and pressure relate to power and transmission

Describe physical and chemical properties of a fluid

Describe fluids in motion in closed conductors

Describe continuity of mass flow

Identify types of fluids

Identify properties of fluids

Identify English and metric units of measurement for pressure, density, and viscosity

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M

**Competency:**      **Describe energy considerations**

**Competency Builders:**

- Differentiate work and power
- Differentiate potential and kinetic energy
- Explain energy conservation concept
- Explain hydraulic horsepower
- Explain work of compression in compressible fluids

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S,M

**Competency:** **Describe component operation**

**Competency Builders:**

Identify functions and operation of hydraulic components

Identify functions and operation of pneumatic components

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,S

**Competency:** Interpret hydraulic and pneumatic schematics

**Competency Builders:**

Identify common symbols

Sketch circuit diagrams (e.g., schematics)

Interpret circuit diagrams (e.g., schematics)

Sketch circuit analysis

Diagram an air supply system

## **Unit: Computerized Numerical Control (CNC) for EM**

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill Standards developed by the Metalworking Industry Skills Standards Board. Source: *Duties and Standards for Machining Skills. Level II. Duties 2.22 and 2.23.* January 1995.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**      **Demonstrate knowledge of CNC**

### **Competency Builders:**

Define numerical control (NC) and computerized numerical control (CNC)

Differentiate NC and CNC

Describe closed loop, open loop, and adaptive controls

Define point to point systems

Identify tool movement of point to point systems

Define continuous path systems

Identify tool movements of continuous path systems

Define canned cycles

Differentiate hardware and software

List advantages/disadvantages of CNC machining centers

Explain direct numerical control (DNC)

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
		P	

**Competency:**      **Perform preventive maintenance**

**Competency Builders:**

Follow proper safety procedures

Clean CNC equipment

Lubricate CNC equipment

Identify wear and alignment issues on CNC equipment

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC

**Competency:** Prepare CNC program

**Competency Builders:**

Write a program manually in word address format

Write a program off line

Write a program manually in conversational program

Generate a program using a CAD/CAM package

Program machine using manual data input (MDI) process

## **Unit: Computerized Numerical Control (CNC) for IM**

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill Standards developed by the Metalworking Industry Skills Standards Board. Source: *Duties and Standards for Machining Skills. Level II. Duties 2.22 and 2.23.* January 1995.

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:** Demonstrate knowledge of CNC

**Competency Builders:**

Define numerical control (NC) and computerized numerical control (CNC)

Differentiate NC and CNC

Describe closed loop, open loop, and adaptive controls

Define point to point systems

Identify tool movement of point to point systems

Define continuous path systems

Identify tool movements of continuous path systems

Explain the purpose of the post-processor

Define canned cycles

Differentiate hardware and software

Differentiate among CNC, machining centers, and robots

List advantages/disadvantages of CNC machining centers

Explain direct numerical control (DNC)

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Perform preventive maintenance

**Competency Builders:**

Follow proper safety procedures

Clean CNC equipment

Lubricate CNC equipment

Check CNC equipment for wear and alignment

Identify wear and alignment issues on CNC equipment

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C

**Competency:**      **Apply CNC operations**

**Competency Builders:**

- Identify parts of the machine
- Apply basic programming skills to a turning and a milling operation
- Select proper work holders
- Select proper cutting tools
- Set machine parts to drawing tolerances
- Use CAD/CAM for part program development
- Apply proper set-up procedures

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Prepare CNC program**

**Competency Builders:**

Write a program manually in word address format

Write a program off line

Write a program manually in conversational program

Generate a program using a CAD/CAM package

Program machine using manual data input (MDI) process

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**            **Program CNC operations**

**Competency Builders:**

- Apply ANSI drawing standards
- Apply process planning from drawing to finished product
- Analyze workpiece
- Contrast differences in computer-assisted programming
- Perform basic trigonometric computations
- Perform special perception mathematical computations
- Set chip load, feed rates, and surface feet per minute limitations
- Turn intersection points into segments (e.g., defined in terms of points, lines, and circles)
- Debug program

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Load machine**

**Competency Builders:**

Load program from MDI and/or off-line programming station

Prepare work-holding device

Mount work-holding device

Secure workpiece

Set up reference and clearance points

Set up tooling

Select proper lubrication/coolant

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M

**Competency:**      **Operate CNC machine**

**Competency Builders:**

- Perform dry run
- Load raw material
- Start cycle
- Monitor work in-process
- Edit CNC programs
- Demonstrate ability to halt running program
- Inspect part
- Apply proper safety procedures
- Demonstrate proper cleaning of CNC machine

## **Unit: Precision Machining**

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill developed by the Metalworking Industry Skills Standards Board. Source: *Duties and Standards for Machining Skills. Level I. Duties 1 and 2.* November 1994.

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	C,M

**Competency:**      **Perform prerequisite machining skills**

**Competency Builders:**

Demonstrate maintenance of immediate work area, machinery, tools and gages

Demonstrate proficiency in interpreting prints/drawings

Demonstrate proficiency in planning work sequence/set up

Follow safety rules and regulations for each machine

Identify and use personal protective equipment for each machine

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C

**Competency:**      **Analyze machine shop jobs**

**Competency Builders:**

- Identify sequence of work on specified project(s)
- Identify tolerances and finishes on specified project(s)
- Identify variables that effect job efficiency (e.g., speeds, feeds)
- Use machinery handbook
- Identify causes of workpiece defects

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,C

**Competency:**      Achieve machine shop job standards

**Competency Builders:**

Write machine shop job procedure

Complete machine shop job status report(s)

Analyze machine shop job evaluation data

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,S

**Competency:**      Perform bench operations

**Competency Builders:**

Use measuring instruments and hand tools

Deburr workpiece

Lay out workpiece

Drill hole

Hand tap hole

Cut threads with die

Apply basic metallurgy knowledge

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,S,C

**Competency:**      **Operate metal cutting saw**

**Competency Builders:**

- Identify types and uses
- Transfer dimensions from blueprint
- Clean metal cutting saw
- Lubricate metal cutting saw
- Install guides
- Adjust guides
- Select proper blades
- Weld saw blade
- Install saw blade
- Select speeds and feeds
- Cut metal
- Deburr workpiece
- Apply basic metallurgy knowledge
- Identify proper cutting fluids

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	P	R	M,S,C

**Competency:**      Operate drill press

**Competency Builders:**

Clean drill press

Lubricate drill press

Identify proper cutting fluid

Mount part in holding device/fixture

Select proper bit, speed, and feed

Demonstrate proper bit sharpening techniques

Drill part

Countersink

Tap hole

Apply basic metallurgy knowledge

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**            **Operate tool and cutter grinding machine**

**Competency Builders:**

Identify parts of machine

Identify proper cutting fluids

Identify causes of workpiece defects

Select proper wheels and work holding devices (e.g., superabrasives)

Perform truing operations

Perform dressing operations

Perform forming operations

Select proper speeds and feeds

Sharpen end mill

Sharpen horizontal milling cutter

Sharpen drills and countersinks

Apply basic metallurgy knowledge

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**      **Operate pedestal grinder**

**Competency Builders:**

- Clean pedestal grinder
- Lubricate pedestal grinder
- Identify proper wheel
- Identify proper coolant
- Check wheel for defects
- Mount wheel
- Position guard and rest
- Dress wheel
- Sharpen drill bit
- Apply basic metallurgy knowledge

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**            **Operate lathe**

**Competency Builders:**

Clean and lubricate lathe

Deburr

Demonstrate use of a 4-jaw chuck

Identify proper cutting fluid

Identify proper tools and holders

Sharpen tools properly

Mount workpiece

Use dial indicator

Position guards

Select feed(s) and speed(s)

Face workpiece

Turn shaft

Turn taper

Knurl workpiece

Cut off workpiece

Center drill hole

Cut threads (inside and outside)

Turn inside bore

Demonstrate use of steady rest

Demonstrate use of centers

Apply basic metallurgy knowledge

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S,C

**Competency:**            **Operate milling machine**

**Competency Builders:**

- Clean milling machine
- Lubricate milling machine
- Identify proper cutting fluid
- Select proper tool
- Select proper feeds and speeds
- Type of cut (e.g., climb, std.)
- Mount workpiece
- Mount tool
- Mill surface
- Mill keyway
- Drill workpiece
- Bore with milling machine
- Mill angle
- Apply basic metallurgy knowledge

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:**      Operate surface grinder

**Competency Builders:**

- Clean surface grinder
- Lubricate surface grinder
- Identify proper cutting fluid
- Select proper wheel
- Select proper speeds and feeds
- Check wheel for defects
- Mount wheel
- Position guard
- Dress wheel
- Identify proper mounting techniques
- Mount workpiece
- Set surface grinder
- Apply basic metallurgy knowledge

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,C,M

**Competency:**      Select materials

**Competency Builders:**

Interpret color codes, numbering systems, and classification systems of materials  
(e.g., ANSI, SAE)

Identify metals using spark test

Identify metals using variety of tests

Identify materials

Apply basic metallurgy knowledge

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M

**Competency:**            **Perform heat treatment and testing of metals**

**Competency Builders:**

Test hardness of metals

Perform non-destructive testing

Perform destructive testing

Harden metals to job specifications

Temper metals to job specifications

Anneal metals to job specifications

Normalize metals to job specifications

Case harden metals to job specifications

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	C,S,M

**Competency:**      **Explain nontraditional machining processes**

**Competency Builders:**

- Describe principles of chemical etching
- List applications of chemical etching
- List advantages/disadvantages of chemical etching
- Describe principles of photochemical etching
- List applications of photochemical etching
- List advantages/disadvantages of photochemical etching
- Describe electrical-discharge machining (EDM)
- List applications of Plunge EDM
- Differentiate between Plunge EDM and wire EDM
- List applications for wire EDM
- Describe principles of electrochemical machining
- List applications of electrochemical machining
- List advantages/disadvantages of electrochemical machining
- Describe principles of water jet cutting
- List applications of water jet cutting
- Describe principles of torch cutting
- List applications of torch cutting
- Describe principles of laser cutting
- List applications of laser cutting
- List advantages/disadvantages of laser cutting
- Describe shot peen
- Describe media finish
- Describe glass bead
- Describe principles of laser welding

**BIL:**            Essential

<b>EDU:</b>	12	AD	AC
	I	P	S,M,C

**Competency:**            **Perform precision layouts**

**Competency Builders:**

- Identify appropriate tools for measuring
- Describe precision, accuracy, tolerance, reliability, and discrimination
- Distinguish between precision and semiprecision measuring
- Define standard stock dimensions and tolerances
- Demonstrate knowledge of different units of measure (metric, standard, inches)
- Describe common measurement errors and correction procedures
- Calibrate measuring machines and devices
- Demonstrate care of measuring instruments
- Demonstrate use of rule
- Demonstrate use of tape
- Demonstrate use of pi tape
- Demonstrate use of combination square
- Demonstrate use of calipers
- Demonstrate use of micrometers (inside and out)
- Demonstrate use of dial indicators
- Demonstrate use of sine bar
- Demonstrate use of gauges (e.g., dial bore, dial snaps)
- Demonstrate use of surface plate
- Demonstrate use of protractor
- Explain use of profilometer
- Demonstrate use of thermometer
- Demonstrate use of dividers
- Demonstrate basic use of gauge blocks
- Demonstrate use of threading specs
- Explain use of optical comparitor
- Explain use of digital instruments
- Explain use of electronic gauging equipment
- Explain use of data acquisition equipment

Explain operation of manual coordinate measuring machine (CMM)  
Explain use and application of laser alignment/measurement

## **Unit: Metal Stamping Dies**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:** **Describe different types of dies**

**Competency Builders:**

- Describe crimping die
- Describe parts assembly die
- Describe CAM bending die
- Describe blanking die
- Describe pierce die
- Describe forming die
- Describe draw die
- Describe progressive die

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:** Describe fixtures

**Competency Builders:**

- Describe crimping fixture
- Describe locating fixture
- Describe press fitting fixture
- Describe riveting fixture
- Describe welding fixture

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,S,C

**Competency:** Design product

**Competency Builders:**

- Draw isometric view of product
- Construct model (e.g., clay, form, wood, plastic)
- Scan model
- Wire frame data
- Create computerized model
- Interface model with CAD/CAM
- Reproduce surface finish
- Identify materials for product
- Create prototype
- Validate product
- Standardize product

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S,M,C

**Competency:** Troubleshoot design errors

**Competency Builders:**

- Isolate cause of die component breakage
- Isolate cause of failure of parts to be removed from die
- Isolate cause of incorrect punch clearance
- Isolate cause of incorrect die clearance
- Isolate cause of misfitting die components

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C

**Competency:** Correct design errors

**Competency Builders:**

- Correct cause of die component breakage
- Correct cause of failure of parts to be removed from die
- Correct cause of improper punch clearance
- Correct cause of improper die clearance
- Correct cause of misfitting die components

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,M,S

**Competency:** Explain die processing

**Competency Builders:**

Describe preplanning activities

Describe die layout

Identify die operations (e.g., number, purpose and sequence of die operations)

Describe feasibility study development

Describe sequence of operations from die construction

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,M,S

**Competency:** Explain pattern shop applications

**Competency Builders:**

- Describe pattern shop activities
- Describe die pattern materials (e.g., wood, styrofoam, ceramic)
- Describe die pattern construction
- Describe casting of dies
- Describe casting of components
- Describe model process steps
- Describe model use

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,S,C

**Competency:** Explain die construction (e.g., production and operation techniques)

**Competency Builders:**

- Explain need for basic machining skills
- Explain need for sculptured machining skills
- Explain EDM functions
- Explain die material standards
- Describe tool and die welding
- Describe punch finishing
- Explain lifter/gauging systems
- Explain pressure systems
- Describe function of cams

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C

**Competency:** Explain the die tryout process

**Competency Builders:**

Explain need to use analytical problem solving for die tryout

Describe process documentation

Describe die modification techniques

Describe blank modification techniques

Describe die buy-off

Describe die release

Describe part release

Describe die coatings

Describe die treatments

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:** Explain die maintenance

**Competency Builders:**

- Describe planned die maintenance
- Describe predictive die maintenance
- Describe preventive die maintenance
- Describe die maintenance troubleshooting techniques
- Describe die refurbishment techniques

## **Unit: Press Technology**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Explain press operation

### **Competency Builders:**

Identify types of presses

Describe functions of presses

Identify capacity of presses

Identify operator safety devices

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Demonstrate knowledge of press accessories

**Competency Builders:**

Describe function of monitors, proximity switches and die protection

Describe function of loaders

Describe function of roller levelers

Describe function of decoilers

Describe function of feeders

Describe function of transfer mechanisms

Describe function of lubricators and coolants

Describe processing of coil steel

Describe use of SMED change

Describe press set-up

# **Unit: Sheet Metal Fabrication**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C,S

**Competency:** Demonstrate knowledge of sheet metal fabrication

## **Competency Builders:**

- Describe sheet metal fabricated products
- Describe press working process
- Describe process(es) of straightening metal
- Describe metal finishing and coating
- Explain bend allowances
- Identify materials used for sheet metal fabrication (e.g., hot roll, cold roll, aluminum, stainless)
- Explain process of determining metal thicknesses
- Explain process of layout
- Explain process of fastening
- Explain process of punch and die clearance and alignment
- Demonstrate the capability to finish (cleaning, painting, plating)
- Demonstrate CADD uses for layout

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,M

**Competency:** Describe types of metal fabrication manufacturing

**Competency Builders:**

Describe shear

Describe press brake

Describe cut-to-length lines

Describe roll forming

Describe computer numerical control (CNC) turret presses

Describe flexible manufacturing system (FMS) cells

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Layout sheet metal

**Competency Builders:**

Lay out 90° ell

Lay out 95° and 30° ell

Use radial line development to lay out

Use development by triangulation to lay out

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** **Fabricate components**

**Competency Builders:**

Layout design

Measure materials

Create pattern and/or prototype

Use hand tools

Cut materials

Form materials

Use temporary and permanent fasteners

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M

**Competency:** Perform sheet metal fabrication

**Competency Builders:**

Identify sheet metal fabrication jobs

Identify tools needed (e.g., manual and hand powered)

Fabricate round ells

Fabricate tees

Fabricate pyramids

Fabricate cones

Fabricate transitions

# **Unit: Basic Moldmaking**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C

**Competency:** Explain processes for building molds

## **Competency Builders:**

Describe process of making a mold

Describe machinery used in moldmaking

Describe types of metal used for molds

Identify types of components used in the forming process (e.g., gibs, core, cavity, slides, heaters)

Identify surface finishes for molds

Identify types of molding materials (e.g., glass, plastic, rubber, die cast, pressware)

Describe the fitting and assembly process

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S,C

**Competency:** **Describe the process of extrusion/pultrusion**

**Competency Builders:**

Explain extrusion method/pultrusion

Identify machines and dies used in extrusion

Identify applications for extrusion

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S,C

**Competency:** **Describe compression molding**

**Competency Builders:**

Explain compression molding method

Identify machines and molds used in compression molding

Identify applications for compression

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S,C

**Competency:** Describe injection molding

**Competency Builders:**

Explain injection molding method

Identify machines and molds used in injection molding

Identify applications for injection molding

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,S

**Competency:** Describe blow molding

**Competency Builders:**

Explain blow molding method

Identify machines and molds used in blow molding

Identify applications for blow molding

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,S

**Competency:** Describe thermoforming

**Competency Builders:**

Explain thermoforming method

Identify machines and molds used in thermoforming

Identify applications for thermoforming

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S,C

**Competency:** Describe rotational molding

**Competency Builders:**

Explain rotational molding method

Identify machines and molds used in rotational molding

Identify applications for rotational molding

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	S,C

**Competency:** **Describe calendering method**

**Competency Builders:**

Explain calendering method

Identify machines and molds used in calendering

Identify applications for calendering

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,S

**Competency:** **Describe foam processes**

**Competency Builders:**

Explain foam processes method

Identify machines and materials used in foam processing

Identify applications for foam processes

Identify auxiliary equipment needed

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	C,S

**Competency:** **Describe powder coating**

**Competency Builders:**

Explain powder coating method

Identify machines and materials used in powder coating

Identify applications for powder coating

Identify auxiliary equipment needed

# **Unit: Material Joining Technology**

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	M,C

**Competency:** **Perform basic soldering of electrical components**

## **Competency Builders:**

- Prepare surfaces to be soldered
- Select appropriate solder
- Select appropriate flux
- Select appropriate soldering iron temperature
- Select appropriate soldering iron tip shape
- Select appropriate flux remover
- Select appropriate surface sealant
- Inspect solder joints under microscope
- Identify good and bad solder joints
- Measure solder joint resistance of good and bad joints

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Operate wave soldering machine

**Competency Builders:**

Inspect surfaces to be soldered

Select appropriate solder

Select appropriate flux

Set all machine parameters (e.g., temperature, wave amplitude, transport velocity)

Inspect solder joints of completed printed circuit boards

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Solvent weld plastic joints

**Competency Builders:**

Prepare surfaces to be joined

Select appropriate cleaners

Select appropriate adhesive

Make and inspect joints

Review and adhere to appropriate codes

**BIL:** Recommended

<b>EDU:</b>	12	AD	AC
	I	R	

**Competency:** Thermal weld plastic joints

**Competency Builders:**

Prepare surfaces to be joined

Select appropriate cleaners

Select appropriate heat gun temperature

Select appropriate inert gas and flow rate

Select appropriate plastic rod if required

Make and inspect joints

## **Unit: Welding Basics**

**BIL:** Essential

<b>EDU:</b>	12	AD	AC
	I	P	M,S

**Competency:** **Perform basic gas welding, brazing, and cutting**

**Competency Builders:**

Follow safety guidelines

Differentiate welding and brazing

Identify gas welding and cutting equipment and accessories

Use personal protective equipment required for welding and cutting

Explain capillary attraction as it applies to metal

Demonstrate proper lighting, adjusting, and shutting down of gas torch

Layout mild steel

Cut mild steel

Braze mild steel

Solder non-ferrous metals

Apply basic metallurgy technology

**BIL:**      Essential

<b>EDU:</b>	12	AD	AC
	I	P	

**Competency:**      **Perform basic arc welding/cutting (e.g., stick)**

**Competency Builders:**

- Identify arc welding equipment and accessories
- Explain process of resistance welding
- Explain process of projection welding
- Explain process of flash-butt welding
- Explain process of laser welding
- Explain process of friction welding
- Explain process of spot welding
- Explain process of shielded metal-arc welding (SMAW)
- Explain process of gas metal-arc welding (GMAW)
- Explain process of gas tungsten-arc welding (GTAW)
- Explain process of plasma-arc cutting
- Explain process of carbon arc gouging and cutting
- Explain process of welding plastics
- Explain welding rod alloys
- Read welding rods
- Explain mild steel welding rod
- Explain low hydrogen welding electrode
- Explain rationale for preheating and post-heating metal
- Explain (GMAW) welding in flat, horizontal, vertical positions
- Explain (GTAW) welding on mild steel, stainless steel, and aluminum
- Explain process of build up and hard facing
- Troubleshoot fusion of materials
- Weld stainless steel using (SMAW) process
- Weld steel requiring preheat
- Weld cast iron
- Weld aluminum
- Apply basic metallurgy technology



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